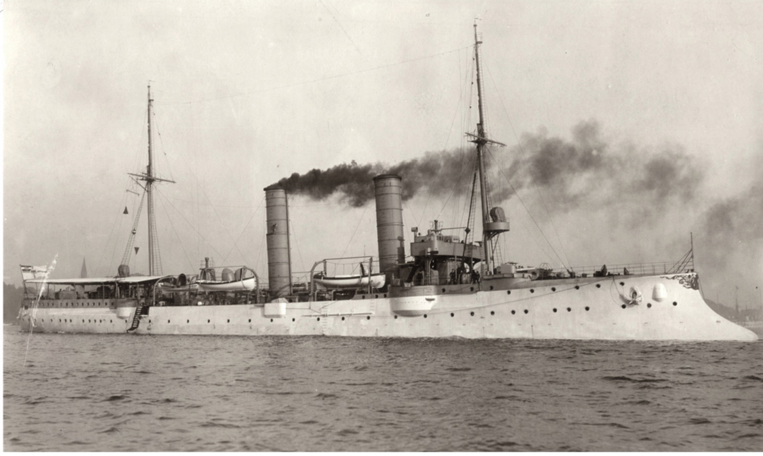
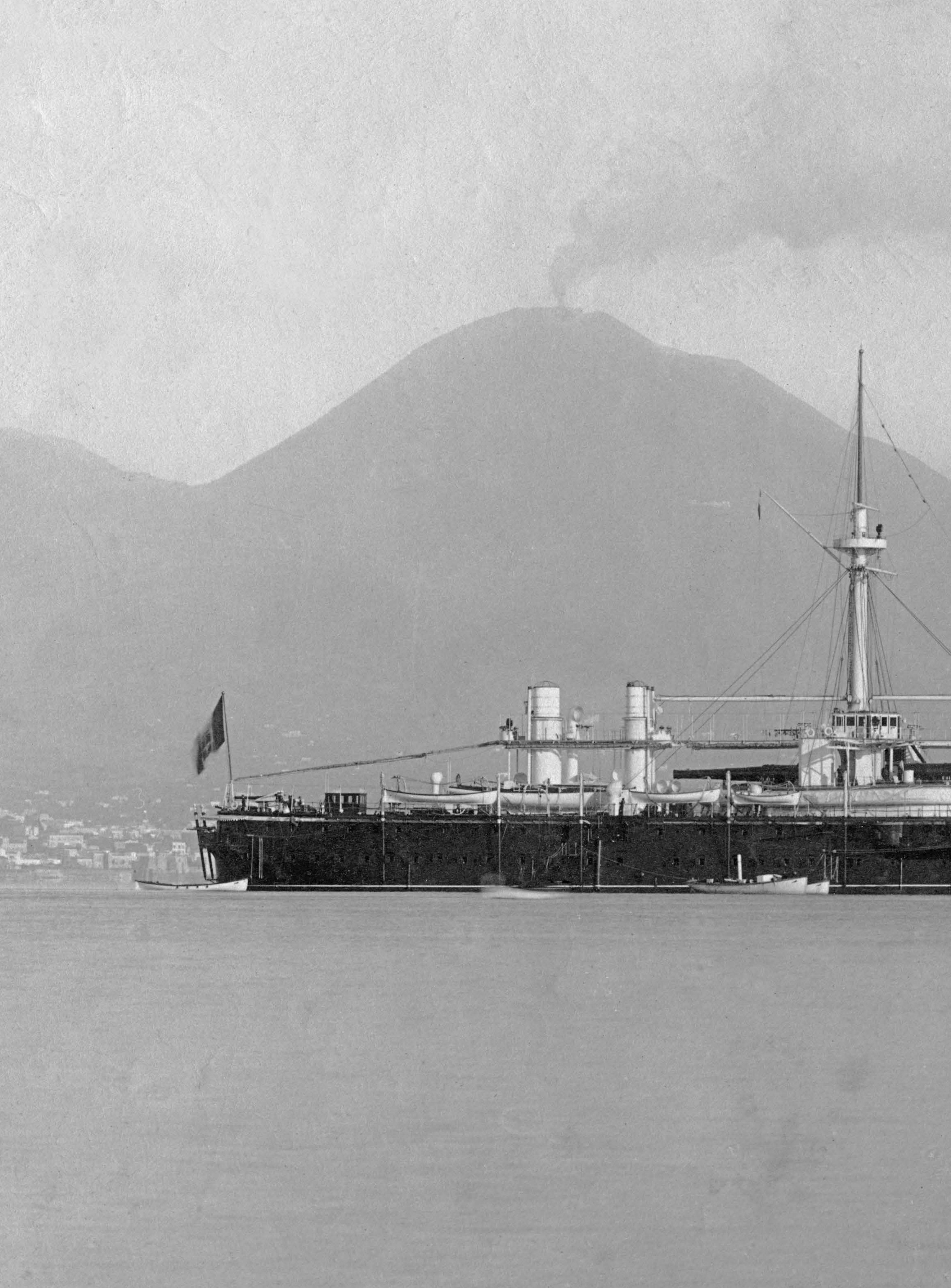
WARSHIP
2020

Edited by John Jordan



OSPREY

WARSHIP 2020



WARSHIP 2020

Editor: **John Jordan**

Assistant Editor: **Stephen Dent**

OSPREY
PUBLISHING

Title pages: The Italian battleship *Lepanto* with Mount Vesuvius in the background. *Lepanto* and her half-sister *Italia* are the subject of an article by Sergei Vinogradov published in this year's annual. (Author's collection)

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EDITORIAL

This year sees the *Warship* debut of two contributors. Some readers may be familiar with the work of Dirk Nottelmann, whose articles for *Warship International* over the past few years on the 'big ships' of the Imperial German Navy have greatly extended our knowledge of the design process and technical characteristics of these vessels. Dirk has agreed to produce a series of articles on the smaller ships of the IGN for *Warship*, beginning with the *Kleiner Kreuzer* ('small cruisers'), of which the first part appears on pages 102–18 of this edition. The articles will use archive material collected by Dr Axel Griessmer, author of one of the most significant works published in German on the battleships and battlecruisers of the period, and whose planned follow-up on the smaller ships failed to materialise.

Our other new contributor is Canadian naval historian Michael Whitby, who has written about the grounding of the light cruiser HMS *Dauntless* on Thrumcap Shoal, Halifax, Nova Scotia, in July 1928. His gripping account of the grounding and of the subsequent salvage operation and Court of Inquiry, which was followed by the Court Martial of the ship's commanding officer Captain Kenneth McPherson and his navigating officer, Lieutenant-Commander (N) Thomas Beatty, provides an insight into not only the hazards of entering a harbour in thick fog before the advent of radar and other electronic navigation aids, but also the standard procedures of the interwar Royal Navy. Michael plans to follow this article with a two-part feature on the employment of Home Fleet destroyers in support of the transatlantic convoys during the spring of 1943, at the height of the war against the U-boats, to be published in *Warship 2021*.

This year's annual begins with a study by the Editor of the French aircraft carrier *Béarn*, one of a number of interwar air-capable ships converted using the hulls of incomplete battleships and battlecruisers in the wake of the Washington Treaty of 1922. Heavily influenced by the British thinking of the day and by the RN's conversions of *Argus* and *Eagle*, *Béarn* nevertheless introduced a number of innovatory technical features of her own, not all of which were successful. Her withdrawal from active service at the beginning of the Second World War would be driven largely by her ageing propulsion machinery and her slow speed, which meant that she was unable to keep pace with the newer battleships.

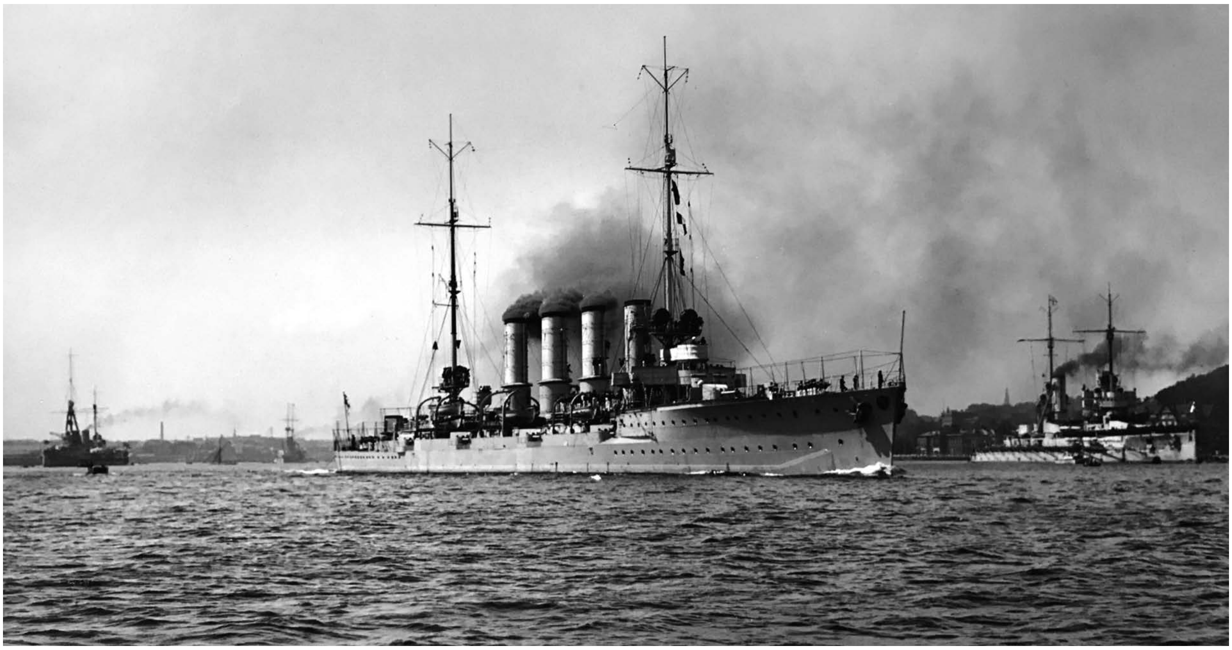
The Italian Navy's record with regard to carrier development between the wars was even less impressive, due in part to the political dominance of the *Regia Aeronautica*, but also to the lack of a genuine commitment to naval aviation on the part of the senior officers of the *Regia Marina*. Michele Cosentino, in the first of two articles on Italian carrier development, takes a close look at some of the projects which failed to materialise.

Two of this year's feature articles focus on battleship design in the 19th century. Sergei Vinogradov's in-depth study of the influential Italian battleships *Italia* and *Lepanto*, in which belt armour was suppressed in favour of a heavily armoured citadel amidships for the big guns and their magazines, a 2in protective deck and tight compartmentation, has been compressed and translated into English by regular contributor Stephen McLaughlin. And Philippe Caresse continues his series on the French battleships of the *flotte d'échantillons* with a study of the first of the four vessels built under the 1890 programme, *Charles Martel*, designed by the distinguished naval architect Charles Huin. Easily distinguished visually from her half-sisters, each of which was designed by a different architect, *Charles Martel* suffered from excessive topweight due to her heavy flying deck and military masts – an issue that was never satisfactorily resolved.

Two decades on from *Charles Martel*, the Imperial Japanese Navy was drawing up plans for a fleet of eight battleships and eight battle cruisers to form the core of two fleets that would be a counterweight to the US Navy in the Pacific. Hans Lengerer's article on the so-called 'Eight-Eight Fleet', which follows the same author's article on the earlier 'Six-Six Fleet' published in *Warship 2019*, demonstrates the extent to which these plans were unaffordable; had they been implemented, they would have brought the country to bankruptcy.

In a new and revealing study of the Soviet Navy between the wars, Przemysław Budzbon and Jan Radziemski investigate the influence of HM Submarine *L 55* on the design of the early Soviet submarines. The new Soviet Government, influenced by the French *Jeune Ecole* of the late 19th century, was committed to a fleet of 'mosquito craft', of which submarines would form the key offensive component, to defend the coastal waters of the USSR. However, Soviet submarine design of the period was hampered not only by the repressive nature of the regime, whose first response to any setback or failure was to imprison or execute the individuals responsible, but by the almost total absence of any historical body of data or experience. The fortuitous discovery of the wreck of *L 55*, which had been despatched by the British on an abortive mission to the Baltic shortly after her completion in late 1918, was therefore a game changer.

The postwar era is represented by three of this year's feature articles. The first is an article by David Hobbs on the reconstruction of the aircraft carrier *Victorious* during the 1950s, a ship on which David served as a Midshipman following her recommissioning. Heavily criticised for delays and costs incurred during the extensive period *Victorious* spent in dockyard hands, the reconstruction nevertheless delivered a ship which formed the base-line for later RN carrier reconstructions and for the design of the abortive CVA-01. Conrad Waters, for the latest in his series of articles on modern



Karlsruhe, one of a series of modern, turbine-powered light cruisers completed for the Imperial German Navy prior to and during the Great War. These ships will be the subject of Part II of Dirk Nottelmann's article on the *Kleiner Kreuzer* to be published in *Warship* 2021. (Dirk Nottelmann collection)

warship developments, looks at the consequences of the many and varied factors influencing surface warship design since the end of the Cold War, with a particular focus on size, 'stealth' features, weapons/sensors and propulsion. And the feature section concludes with a short article by the Editor on the postwar 'fleet escorts' of the French T 47 type, with line drawings of the lead unit *Surcouf* adapted from the official STCAN plans and a brief description of the key weapons and electronics systems developed by the French after the Second World War. It is envisaged that this will be the first of a series of short features and longer articles on the major types of warship designed and built by the French during the postwar era.

This year's Warship Notes has a number of substantial items. David Murfin has submitted a well-researched note on the Royal Navy's post-WWI concept of the Mobile Naval Base, a response to the renewed focus on overseas threats in the aftermath of the Washington Treaty; the note is illustrated by specially-drawn plans of the proposals to convert the battleship *Agincourt* and the cargo liner *Oropesa* to serve as MNB depot ships. Kenneth Fraser has unearthed a letter in the archives of the University St Andrews, Scotland, written by a serving RN lieutenant, Robert Hamilton Anstruther, in the wake of the tragic loss of the turret ship HMS *Victoria* to a collision in 1893; it describes the attempts to rescue the crew and the subsequent services held on board every ship of the Mediterranean Fleet to commemorate the dead.

While the 6in gun turrets fitted in Royal Navy cruisers of the 1930s have received extensive coverage in the literature, this is less true of the Mk XVII and Mk XVIII enclosed twin mountings fitted in the cruiser *Enterprise* and the battleships of the *Nelson* class respectively. With the invaluable assistance of John Roberts, the Editor has put together a note describing in detail the operation of the Mk XVIII mounting, illustrated by labelled drawings of the turret and its distinctive telescopic rammer.

Finally, Stephen Fisher and Nick Hewitt (National Museum of the Royal Navy) provide an account of the rescue and restoration of *LCT 7074*, a veteran of the D-Day landings. Acquired in the late 1990s by the Warships Preservation Trust, which subsequently went into liquidation, the wreck was in a poor condition, and piecing together her history involved much painstaking research. However, the operation to salvage and restore the craft to something like her original condition was a success, and it is hoped that *LCT 7074* will return to Portsmouth around the time *Warship 2020* is published, to be displayed outside the D-Day Museum in Southsea.

This year's annual concludes with the customary A's & A's, reviews of naval books of the year, and a Warship Gallery which features the stunning black and white photographs of Royal Navy warships taken by the distinguished photographers Clive and Sue Taylor during the 1970s and 1980s.

Besides the follow-up articles already mentioned, *Warship 2021* will include major features on the Soviet battleships of the *Sovietskii Soiuz* class by Steve McLaughlin, on the IJN submarines of the *I-15* class and the seaplane carriers of the *Chitose* class, by Kathrin Milanovich and Hans Lengerer respectively, on the royal yacht *Victoria and Albert* (iii) by Ian Sturton, and on the Italian aircraft carrier *Aquila* by Michele Cosentino.

John Jordan
April 2020

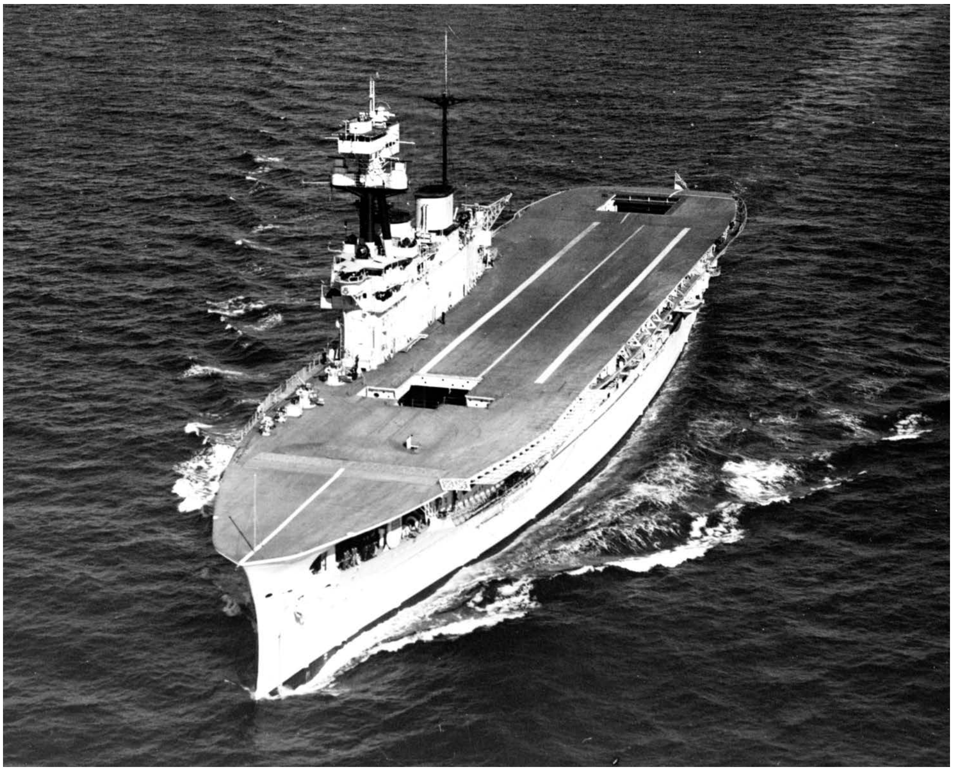
FROM BATTLESHIP TO CARRIER: *BÉARN*

Béarn was the only aircraft carrier completed for the French *Marine Nationale* during the interwar years. A conversion of a battleship hull, like the British *Eagle* and the Japanese *Kaga*, she was essentially experimental and incorporated a number of unusual features, not all of which were successful, and was relegated to second-line service when war broke out in 1939. **John Jordan** provides a study of the development and technical characteristics of the ship.

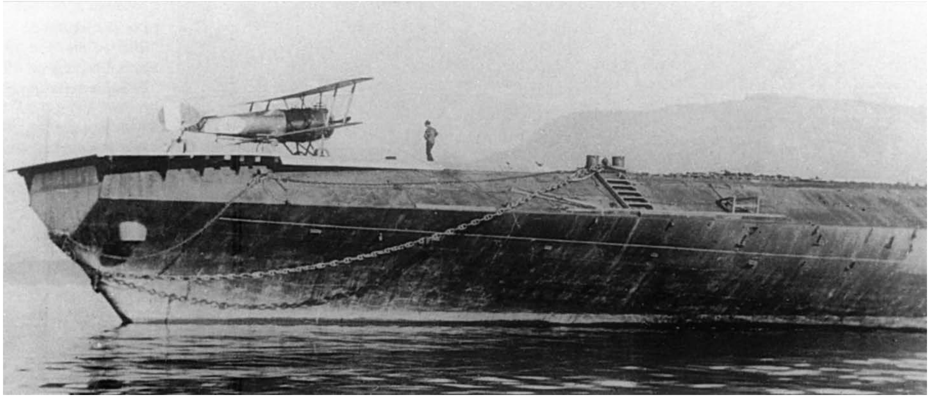
The Washington Treaty, signed on 6 February 1922, prescribed the wholesale scrapping of battleships and battlecruisers currently in build, while at the same time permitting a substantial tonnage that could be allocated to aircraft carriers: 135,000 tons for Britain and the USA, 81,000 tons for Japan, and 60,000 tons for France and Italy. The carrier allocations for the three major powers were based on a theoretical unit displacement of 27,000 tons using a 5:5:3 ratio, those for France and Italy on three ships of about 20,000 tons. These figures, however, related to new purpose-built construction which, it was anticipated, would take place in the 1930s alongside the new generation of 35,000-ton battleships laid down after the ten-year 'holiday'. The conversion of existing capital ship hulls as an interim measure, given that the aircraft carrier as a type was still in its infancy, was not only assumed but was actively encouraged both as an incentive for the major naval powers to accept the draconian prohibitions on new capital ship construction that were under discussion and as a means of securing a return on the investment made in existing hulls, many of which were complete up to the armoured deck.

The British Royal Navy had already begun the reconstruction of two such ships, the former Chilean battleship *Almirante Cochrane* – rechristened *Eagle* – and the 'light battlecruiser' *Furious*, and in July 1921 had approved the conversion of one of *Furious*'s two half-sisters, *Glorious*. At around the same time, in the run-up to the Washington Conference, the US Navy embarked on studies for the reconstruction of two of the incomplete battlecruisers of the *Lexington* class.

France showed more than a passing interest in these



HMS *Eagle* in 1935. Her conversion from a battleship hull makes her the closest in conception of the British carriers to *Béarn*. However, a number of different choices were made as the design developed. The bow was faired into the forward end of the flight deck, and the two lifts were widely separated and located at either end of the hangar. The forward lift was cruciform, enabling aircraft to be struck down with wings deployed immediately on landing. This proved to be a far superior arrangement to that adopted by the French. (Courtesy of David Hobbs)



The initial take-offs and landings using the temporary wooden flight deck were made by LV Paul Teste in a two-seat Sopwith 1½ strutter in October 1920. During the 1921 trials, the Sopwiths were replaced by the two-seat Hanriot HD.3. The aircraft in the photo is being prepared for take-off. In order to give the aircraft the correct attitude the rear of the fuselage has been raised on a trestle. (Private collection)

developments. In early 1920 a French commission visited Britain and was given a tour of the first 'through-deck' carrier conversion, HMS *Argus*, to observe aircraft handling and flying operations. According to David Hobbs,[1] drawings of *Eagle*'s aviation and island arrangements were also made available. Out of this visit came a proposal for the conversion of one of the incomplete battleships of the *Normandie* class, and this was duly incorporated in a new building programme designated Project 171. Staff requirements included:

- the embarkation of the maximum number of wheeled aircraft, and the ability to operate seaplanes in harbour
- a continuous wooden flight deck at least 150m long, with the maximum possible width and no obstructions
- a hangar connected to the flight deck by two lifts, of which the larger should be 20m by 12m
- an access bay 20m wide for seaplanes at the after end of the hangar
- speed and endurance comparable to the battleships of the *Bretagne* class (ie 21 knots, 6000nm at 10 knots)
- light vertical armour plating and protection against mines and torpedoes.

The hull of *Béarn*, which had been launched without ceremony to clear the slipway on 15 April 1920 and was complete up to the lower armoured deck, was selected for trials. Initial modifications involved a wooden platform 43m by 9m with an access ramp constructed directly on top of the lower armoured deck. The improvised arrester system used for the trials was based on transverse cables raised on circular pieces of cork and weighted with bags of sand. Successful take-offs and landings at Toulon during late October 1920 led to initial studies by the STCN for a full conversion. However, there was still some hesitation about whether it would be better to complete the ship as a battleship or a carrier, and no final decision was made.

The Washington Conference then intervened. Following its conclusion the *Marine Nationale* decided to proceed with the proposed conversion of *Béarn*, and this decision was formalised in the 1922 Naval Programme. *Béarn* was selected rather than one of her sisters because she was the least complete; she would therefore be easier to modify without having to dismantle much of the existing steelwork, while at the same time having access to the machinery and other components already delivered for the other ships. Detailed plans were drawn up – although they would subsequently be subject to numerous modifications – and the contract for completion by the builder, F C Méditerranée at their La Seyne shipyard, was signed on 4 August 1923. The anticipated cost was 66.33 million French francs, of which 190,000FF were for the demolition of existing structures (452 tonnes).

A Tactical Framework

The influence of Britain's Royal Navy, rightly regarded as being at the forefront of naval aviation, went far beyond the technical and the operational. The Royal Navy of 1918 saw the aircraft carrier as key to providing scouting for the battle fleet in three dimensions, so reconnaissance aircraft were initially to be the key component of the air group. The air space over the battle fleet would also need to be denied to the enemy, hence the need for fighters. These ideas would subsequently be developed: it became clear that aircraft would be equally useful for spotting for the big guns, given ever-increasing ranges of engagement, for torpedo attack, which had the potential to slow an enemy fleet attempting to escape, and for anti-submarine patrol.

The air group initially envisaged for *Béarn* was to comprise two squadrons each of twelve reconnaissance aircraft plus a single squadron of eight fighters, for a total of 32 aircraft. The second reconnaissance squadron would subsequently be replaced by a squadron of torpedo attack aircraft. This conformed with RN theory and practice.

Royal Navy thinking around 1920 favoured two different types of aircraft carrier: one designed to operate in company with the battle fleet, with an air group comprising fighters, spotters and torpedo attack aircraft, the other intended to operate with the strategic scouting forces in the van, the air group being biased towards fighters and reconnaissance aircraft. Both types would need a small speed margin over the ships they would accompany, so the slower carriers (initially *Argus* and

Eagle) would operate with the battle fleet, while the converted light battlecruisers, which were capable of top speeds in excess of 30 knots, would operate with the battlecruisers and light cruisers in the van.

The French had no battlecruisers, and the armoured cruisers that had survived the war were little faster than the 20/21-knot dreadnoughts, hence the staff requirement for speed and endurance comparable to the battleships of the *Bretagne* class. It would, in any case, have proved difficult to increase the top speed of *Béarn* beyond that of the original *Normandie* design given that a proportion of the hull volume occupied by machinery in the original plans would have to be reallocated to provide air ordnance magazines, aircraft spares and aviation fuel under armour. Nevertheless, the lack of any speed margin over the battleships showed a lack of appreciation of the need for an aircraft carrier to manoeuvre independently in order to launch and land aircraft into the wind.

Machinery and Lower Hull

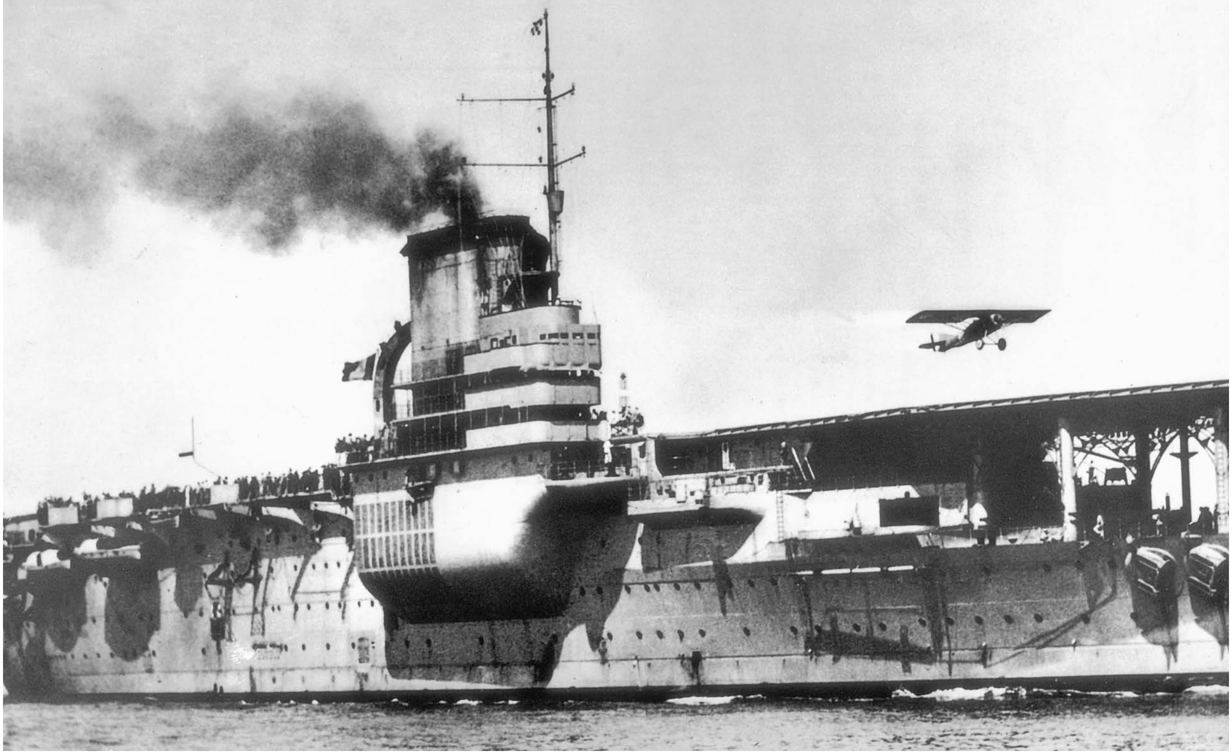
When *Béarn* was launched in 1920 she was complete only to the lower armoured deck. Neither the armour belt nor the propulsion machinery was in place.

As designed the first four ships of the *Normandie* class were to have a composite propulsion plant, with turbines (for high speed) on the inner shafts and reciprocating engines (for cruising/endurance) on the wing shafts. *Béarn*, on the other hand, would have had turbines throughout, to make it easier for her to operate in company with the three ships of the *Bretagne* class.

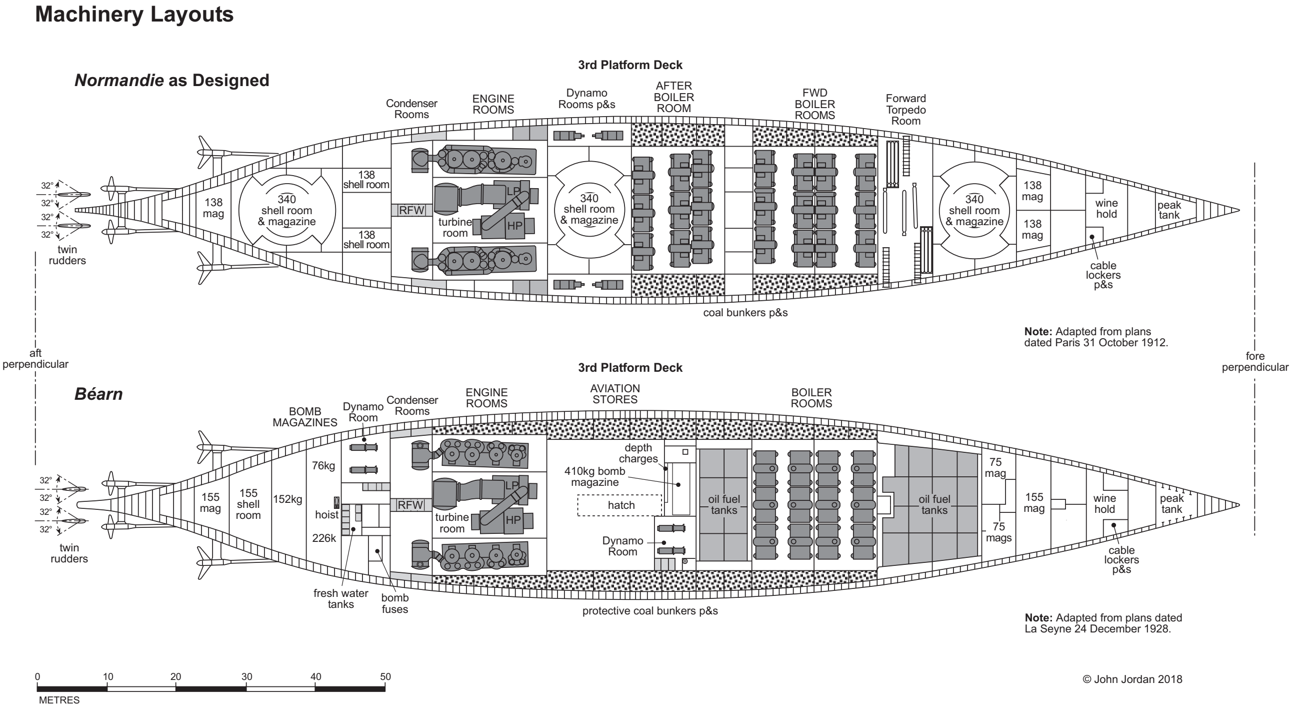
Steam for the reciprocating engines and the turbines was to be supplied either by 21 Guyot–du Temple–Normand boilers, or 28 Belleville boilers, both models being rated at 20kg/cm^2; the Belleville boiler was of the traditional large watertube type, while the Guyot–du Temple–Normand boiler was a small-tube model derived from the boilers fitted in contemporary destroyers. The boilers were disposed either as seven rows of three or seven rows of four in three boiler rooms. Both types burned coal, for which there was extensive bunkerage outboard of the boiler rooms (see Machinery plan)

The reversion to a composite propulsion plant in the *Normandie* class was the result of experience with direct drive turbines in the battleships of the *Danton* class. When the latter ships entered service in 1911 it quickly became apparent that coal consumption at moderate speeds was extraordinarily heavy. Since ships spent most of their active service lives steaming at cruise speed, even in time of war, this was a major concern. There was a cost in endurance, a financial cost, and a heavy price to pay for the crews: coaling was a tedious, dirty and back-breaking task which with high fuel consumption had to be performed with even greater frequency. It was anticipated that the reciprocating engines on the outer shafts would provide a range of 3,375nm at 16 knots and 6,500–6,600nm at 12 knots (almost twice the radius of the *Bretagne* class).

For *Béarn* as a carrier it was decided to adopt the



A Gourdou-Leseurre GL.22 single-seat trainer takes off from *Béarn* during landing trials April–June 1927. Note that the forward 155mm casemate guns have not yet been embarked. (Private collection, courtesy of Philippe Caresse)


Machinery Layouts
Normandie as Designed
3rd Platform Deck
Condenser Rooms
ENGINE ROOMS
Dynamo Rooms p&s
AFTER BOILER ROOM
FWD BOILER ROOMS
Forward Torpedo Room
32°
twin rudders
138 mag
340 shell room & magazine
138 shell room
RFW
LP
HP
turbine room
138 mag
wine hold
peak tank
cable lockers p&s
coal bunkers p&s
Note: Adapted from plans dated Paris 31 October 1912.
aft perpendicular
fore perpendicular
Béarn
BOMB MAGAZINES
Dynamo Room
AVIATION STORES
BOILER ROOMS
155 mag
155 shell room
152kg
76kg
hoist
226k
depth charges
410kg bomb magazine
hatch
oil fuel tanks
75 mag
75 mags
155 mag
fresh water tanks
bomb fuses
protective coal bunkers p&s
Note: Adapted from plans dated La Seyne 24 December 1928.
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METRES
© John Jordan 2018

composite plant planned for her sisters, and to utilise the reciprocating engines and turbines intended for the first ship of the class, *Normandie*. Each of the VTE engines in the wing compartments, built by A C Loire at their Saint-Denis factory, had four cylinders (HP, IP and two LP), and drove a four-bladed propeller with a diameter of 5.2 metres; shaft revolutions were 115rpm. Quite apart from their greater efficiency at low and moderate speeds, the reciprocating engines had the advantage of being able to be reversed to drive the ship when going astern.

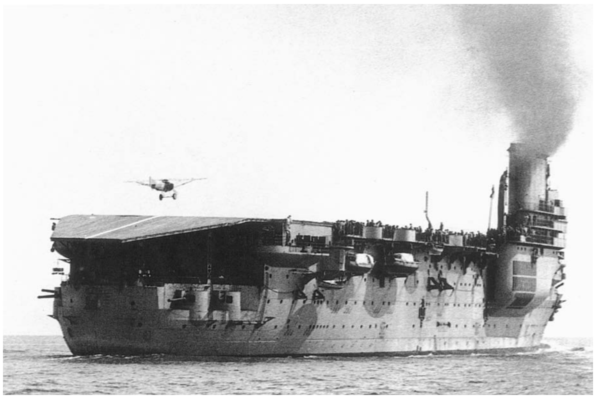
The turbines in the inner compartment comprised a single HP turbine (to starboard) feeding into a single LP turbine (to port), both of the Parsons type and likewise built by A C Loire. The turbines were ahead-only, and the adoption of a composite power plant meant that there was no need for separate cruise turbines. The propellers driven by the turbines on the inner shafts were of high-resistance bronze; they had three blades and a diameter of 3.44m; shaft revolutions at full speed were 280rpm. The twin balanced rudders were directly abaft the centre shafts; each had a surface area of 20.7m^2.

The main condenser for the turbines was located in the centre engine room just forward of (and above) the LP turbine. The condenser rooms for the reciprocating engines were directly abaft the outer engine rooms, and were separated by feed water tanks disposed along the ship's axis.

By the time the reconstruction of *Béarn* had been authorised, oil firing had been adopted for all new construction. Oil not only had a higher calorific value than coal, but it could be pumped on board and around the ship, thereby easing the task of the stokers and enabling their numbers to be reduced. It was decided to replace the original boilers with a new type of Normand small water-tube oil-fired boiler. Only twelve were needed to supply the necessary steam for the 40,000CV propulsion machinery, and these were accommodated in the forward pair of boiler rooms and disposed in four rows of three (see plans). The fuel oil was stowed not in the original coal bunkers outboard of the boiler rooms,

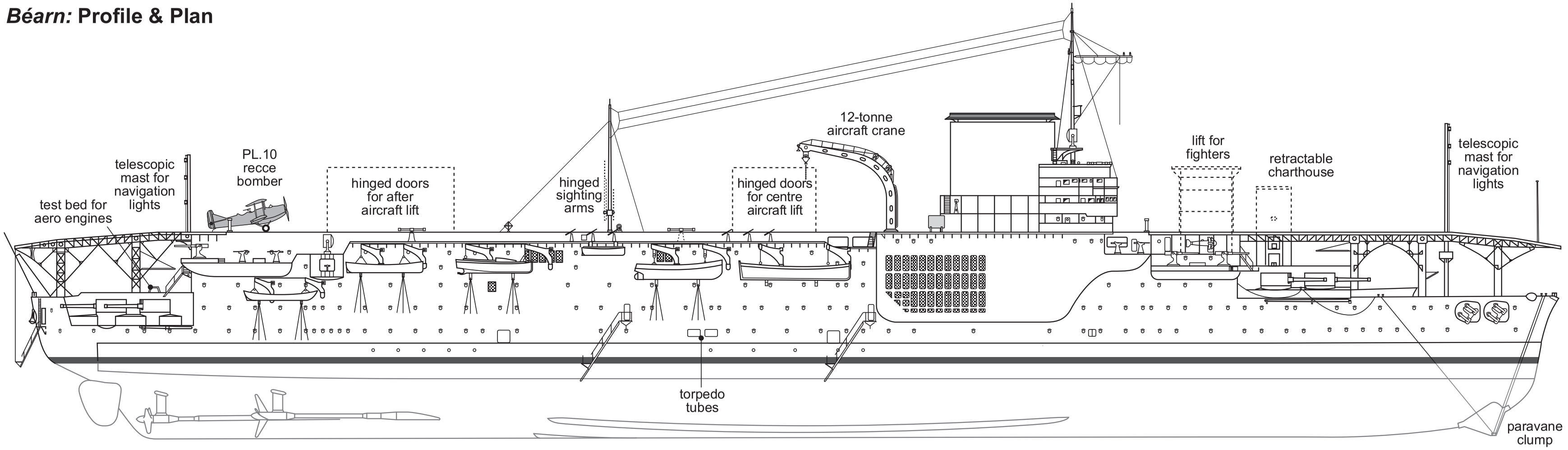
Building Data

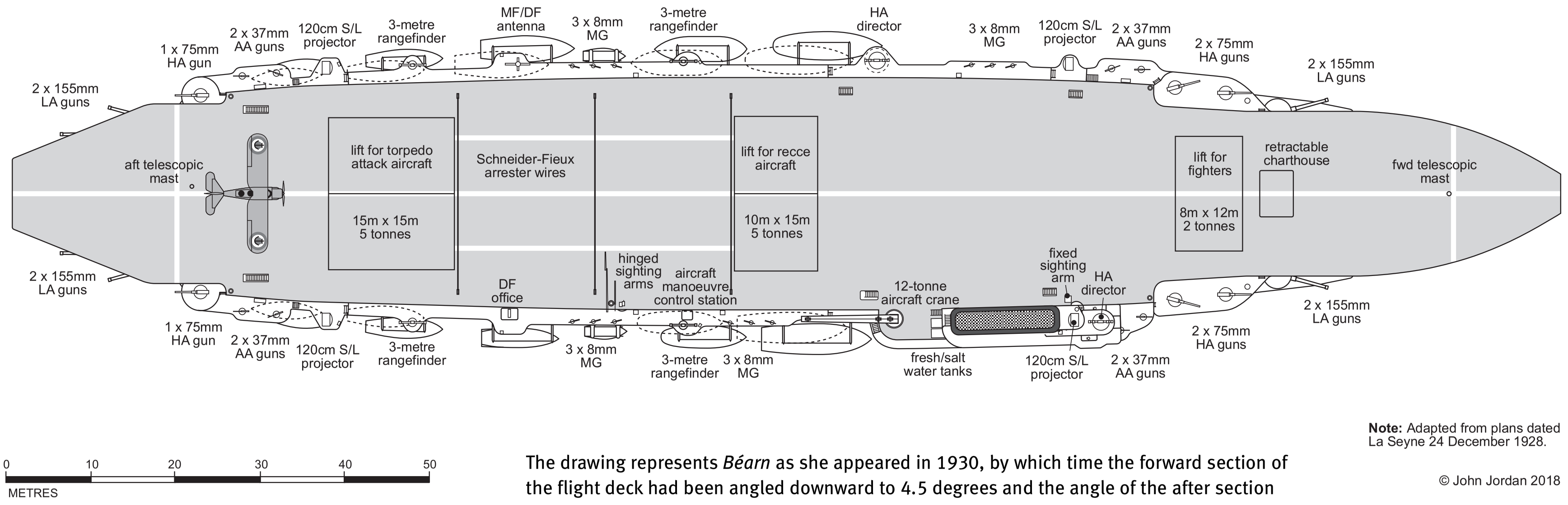
Builder:	F C Méditerranée, La Seyne
Laid down:	5 January 1914
Launched:	15 April 1920
Manned for trials:	1 September 1926
Commissioned:	5 December 1927
Entered service:	1 May 1928



Béarn conducting landing trials with a Gourdou-Leseurre GL.22 trainer April–June 1927. The after section of the flight deck was sloped down at 10 degrees when the ship was first completed. (Private collection)

Béarn: Profile & Plan


test bed for aero engines
telescopic mast for navigation lights
PL.10 recce bomber
hinged doors for after aircraft lift
hinged sighting arms
hinged doors for centre aircraft lift
12-tonne aircraft crane
lift for fighters
retractable charthouse
telescopic mast for navigation lights
torpedo tubes
paravane clump


2 x 155mm LA guns
1 x 75mm HA gun
2 x 37mm AA guns
120cm S/L projector
3-metre rangefinder
MF/DF antenna
3 x 8mm MG
3-metre rangefinder
HA director
3 x 8mm MG
120cm S/L projector
2 x 37mm AA guns
2 x 75mm HA guns
2 x 155mm LA guns
aft telescopic mast
lift for torpedo attack aircraft
15m x 15m 5 tonnes
Schneider-Fieux arrester wires
lift for recce aircraft
10m x 15m 5 tonnes
lift for fighters
8m x 12m 2 tonnes
retractable charthouse
fwd telescopic mast
2 x 155mm LA guns
1 x 75mm HA gun
2 x 37mm AA guns
120cm S/L projector
3-metre rangefinder
DF office
3 x 8mm MG
hinged sighting arms
aircraft manoeuvre control station
3-metre rangefinder
3 x 8mm MG
12-tonne aircraft crane
fresh/salt water tanks
fixed sighting arm
HA director
120cm S/L projector
2 x 37mm AA guns
2 x 75mm HA guns
2 x 155mm LA guns
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Note: Adapted from plans dated La Seyne 24 December 1928.

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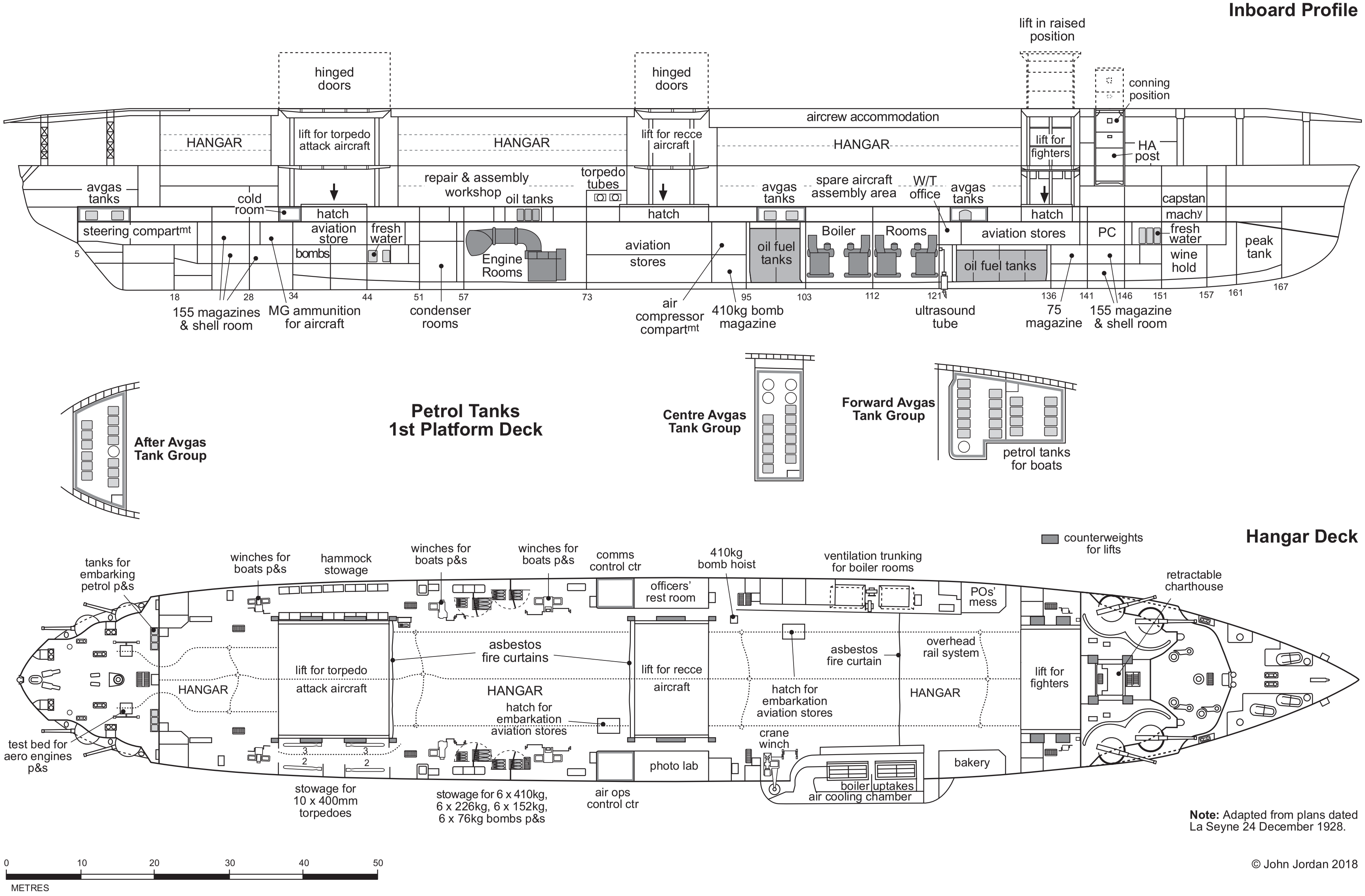
The drawing represents *Béarn* as she appeared in 1930, by which time the forward section of the flight deck had been angled downward to 4.5 degrees and the angle of the after section had been reduced to match. The white lines parallel to the centre-line, marking the landing area, would be extended over the centre lift during 1931, and in September 1932 the after mast would be removed and replaced by aerial spreaders at the after end of the funnel.

Béarn


Inboard Profile
lift in raised position
hinged doors
hinged doors
conning position
HANGAR
lift for torpedo attack aircraft
HANGAR
lift for recce aircraft
aircrew accommodation
HANGAR
lift for fighters
HA post
avgas tanks
cold room
hatch
repair & assembly workshop
oil tanks
torpedo tubes
hatch
avgas tanks
spare aircraft assembly area
W/T office
avgas tanks
hatch
capstan
machy
steering compartmt
aviation store
bombs
fresh water
Engine Rooms
aviation stores
oil fuel tanks
Boiler
Rooms
aviation stores
oil fuel tanks
PC
fresh water
wine hold
peak tank
5
18
28
34
44
51
57
73
95
103
112
121
136
141
146
151
157
161
167
155 magazines & shell room
MG ammunition for aircraft
condenser rooms
air compressor compartmt
410kg bomb magazine
ultrasound tube
75 magazine
155 magazine & shell room
Petrol Tanks 1st Platform Deck
After Avgas Tank Group
Centre Avgas Tank Group
Forward Avgas Tank Group
petrol tanks for boats
Hangar Deck
counterweights for lifts
tanks for embarking petrol p&s
winches for boats p&s
hammock stowage
winches for boats p&s
winches for boats p&s
comms control ctr
officers' rest room
410kg bomb hoist
ventilation trunking for boiler rooms
POs' mess
retractable charthouse
HANGAR
lift for torpedo attack aircraft
asbestos fire curtains
HANGAR
hatch for embarkation aviation stores
lift for recce aircraft
asbestos fire curtain
overhead rail system
hatch for embarkation aviation stores
HANGAR
lift for fighters
test bed for aero engines p&s
3
2
3
2
stowage for 10 x 400mm torpedoes
stowage for 6 x 410kg, 6 x 226kg, 6 x 152kg, 6 x 76kg bombs p&s
air ops control ctr
photo lab
crane winch
boiler uptakes
air cooling chamber
bakery
0
10
20
30
40
50
METRES

Note: Adapted from plans dated La Seyne 24 December 1928.

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but in two groups of tanks fore and aft of the two remaining boiler rooms, the coal bunkers being retained for protection (see below). The forward group of tanks occupied the spaces formerly allocated to the forward torpedo flat and the magazines, shell rooms and handing room for the forward quadruple 34cm gun turret; the after grouping replaced the midship 14cm magazine and part of the original after boiler room.

Once the arrangement of the main propulsion machinery had been fixed it was possible to decide how to reallocate the remaining volume in the lower hull. In general terms this involved the suppression of the magazines, shell rooms and handing rooms for the three 34cm quadruple mountings, together with the magazines and handing rooms for the secondary 14cm battery. The original third boiler room was combined with the ammunition stowage and handling spaces beneath the midship turret to create a capacious aviation store that included a magazine for the largest 410kg bombs, and there were further magazines for aircraft ordnance in place of the 34cm magazine and shell room aft. The magazines for the revised armament (see below) were located at the fore and after extremities of the 2nd and 3rd platform decks.

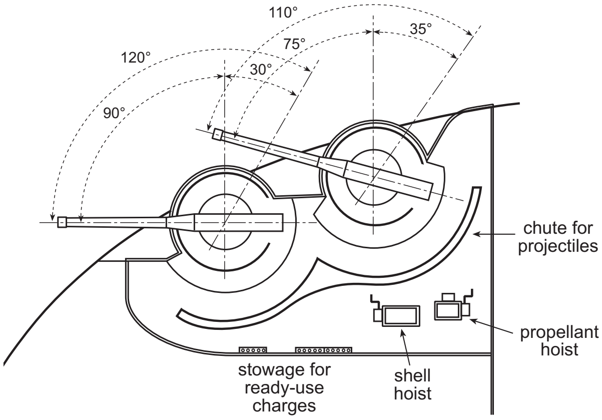
Electrical power for the ship was supplied by steam-powered turbo-dynamos each with an output of 400kW feeding a 230V circuit. The four units installed in *Béarn* were those built for her uncompleted sister *Flandre*. In the original plans they were to have been mounted in wing compartments outboard of the midship 34cm turret; however, in *Béarn* they occupied two compartments offset to port and to starboard abaft and forward of the engine rooms respectively, within the protective 'box'. They would be supplemented by two 150W diesel generators higher up in the ship, located on either side of the main deck, for use when the carrier was alongside.

Protection Against Enemy Vessels

Main guns

It was recognised that independent manoeuvre could potentially expose an aircraft carrier to the enemy's

155mm Casemate



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Characteristics (1928)

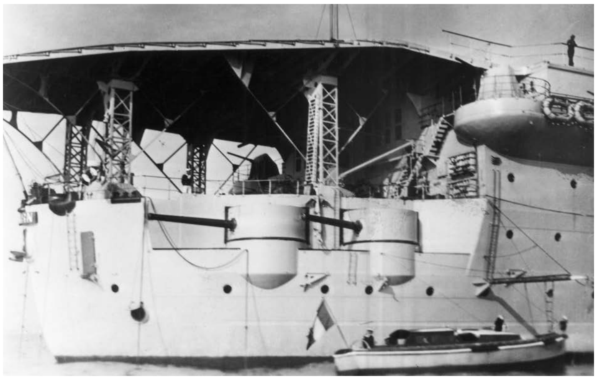
Displacement:	25,335 tonnes normal
Dimensions:	
Length	175.00m pp; 182.50m oa
Beam	27.17m wl
Draught	8.86m aft
Aviation:	
Flight deck	180m x 27m
Height above waterline	15.65m
Hangar	124m x 19.5m x 6.5/5m
Lifts (LxW)	F (fwd): 8m x 12m R (ctr): 10m x 15m T (aft): 15m x 15m
Air group	9 fighters 9 recce bombers 9 torpedo attack
Machinery:	
Boilers	12 Normand small water-tube, 20kg/cm^2
Engines	four-shaft mixed propulsion: two 4-cylinder VTE engines on wing shafts Parsons HP and LP turbines on centre shafts
Propellers	5.20m diameter on wing shafts 3.44m diameter on centre shafts
Horsepower	40,000CV
Speed	21.5 knots
Oil fuel	2,100 tonnes
Endurance	6,500nm at 10 knots
Generators	four turbo-generators each 400kW
Armament:	
LA guns	8 x 155mm/50 Mle 1922 in casemates
HA guns	6 x 75mm/50 Mle 1924 in single mountings
Light AA	8 x 37mm/50 Mle 1925 in single mountings 12 x 8mm Hotchkiss MG Mle 1914
Torpedo tubes	4 a/w tubes for 550mm torpedoes 8 torpedoes Mle 1923D
Protection:	
Main belt	83mm
Decks	24mm PBS + 28/70mm PBI
Casemates	50mm
Boats:	1 x 10-metre steam pinnace 1 x 13-metre motor boat 1 x 11-metre motor boat 1 x 9-metre motor boat 1 x 13-metre pulling pinnace 1 x 11-metre pulling pinnace 2 x 9-metre pulling cutters 2 x 8.5-metre whalers 2 x 5-metre dinghies
Complement:	
As private ship	45 officers, 830 men (includes air group)

advanced scouting forces. The British *Argus* was an experimental mercantile conversion, and was fitted with neither low-angle guns nor protection. However, the carriers *Hermes* and *Eagle* featured not only a battery of low-angle guns comparable to that of a contemporary light cruiser, together with a massive control top to direct low-angle fire, but side and deck armour for the hull capable of withstanding cruiser shell. As originally designed, both ships were to have mounted nine 6in (152mm) guns;[2] *Hermes* was given a 3in (76mm) belt and a 1in (25mm) deck, *Eagle* a 4.5in (114mm) belt and a 1.5in (38mm) deck.

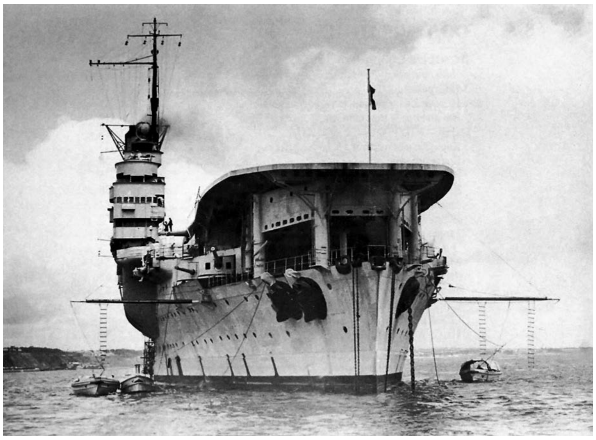
Béarn was completed with eight 155mm guns in casemates, mounted in pairs at the four corners of the ship. The forward two pairs had a command of 10.06 metres, the after guns 6.84 metres. The end guns were capable of end-on fire and had arcs of 120 degrees; the inner guns could fire within 15 degrees of the ship's axis and had slightly reduced arcs of 110 degrees (see drawing).

The 155mm Mle 1920 was a 50-calibre weapon developed for the French Navy's light cruisers of the *Duguay-Trouin* class, the first major new ships to be authorised after the Great War. It fired a an SAP shell weighing 56.5kg with a muzzle velocity of 850m/s using a 19.81kg propellant charge of BM11 in two bags. The projectile, which had a bursting charge of 2.9kg of *mélinite* (picric acid), had a ballistic cap (for increased range) and two driving bands.

In *Béarn* each of the guns was mounted within a cylindrical shield with 50mm on the sides[3] and a 24mm roof. The mountings allowed a maximum elevation of +40 degrees, giving a theoretical range of 25,000 metres, and the guns could be depressed to -3 degrees. There were separate hoists for projectiles and propellant charges for each pair of guns. These were from *Béarn*'s uncompleted sister *Flandre* and were capable of supplying twelve complete rounds per minute; the projectiles were lifted in cases of three, the half-charges in cases of six. There were chutes behind the guns that could hold 18 ready-use projectiles; the corresponding propellant charges were stowed vertically in racks against the rear wall of each casemate. The standard ammunition provision for the LA guns was 2,000 shells, including 500 tracer for night fire, and 4,200 half-charges, equivalent to 250 combat rounds per gun.



Close-up of the after 155mm casemate guns to starboard. The cylindrical shields were protected by 50mm plating. (Musée de la Marine, courtesy of Jean Moulin)



An unusual bow view of *Béarn*, with the forward 155mm casemate guns prominent. The aerial spreaders on the after end of the funnel indicate that the photo was probably taken in 1933–34. (DR)

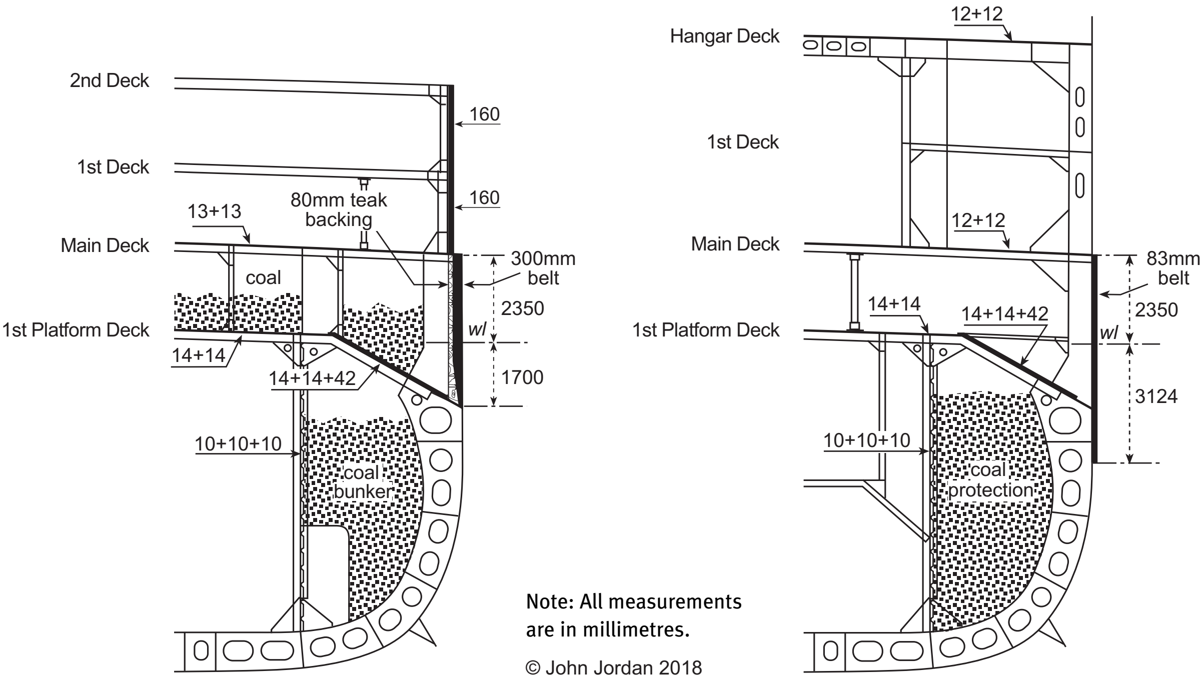
Mounting the 155mm guns in paired casemates at the four corners of the ship meant that they were fore and aft of the hangar, which could therefore occupy the full width of the hull. This meant that hangar volume was significantly greater than in *Hermes* and *Eagle*, which had their LA guns mounted in open shields on either side. However, it also precluded the operation of seaplanes from the quarterdeck, as initially envisaged, because of the location and height of command of the after casemate guns.

Torpedoes

The original plans featured no fewer than twelve above-water tubes for the new 550mm Mle 1923D torpedo, as in the contemporary light cruisers of the *Duguay-Trouin* class. However, the number of torpedo tubes was progressively reduced from twelve to six and finally, following an amendment to the contract dated 12 August 1925, to four. The tubes, which were on the main deck with a command of 3.8 metres, ran on semi-circular tracks that permitted an angle of train of 30 degrees either side of the beam. When not in use they could be retracted within the hull. Eight torpedoes – two per tube – were stowed, complete with warheads, on racks close to the tubes fixed to the side bulkheads of the aircraft assembly and repair area beneath the hangar (see below).

Fire control

Range data for both the main guns and the torpedoes were supplied by four 3-metre coincidence rangefinders mounted on sponsons to port and starboard of the flight deck amidships and aft. The rangefinder arms were given a 0.5-metre clearance above the flight deck to ensure all-round coverage, except where they were masked by the island. The *Postes Centraux*, divided into a lower steering position on the centre-line and a transmitting station to port, were located at the forward end of the



Protection Scheme

Normandie Class

Béarn as Aircraft Carrier

Note: All measurements are in millimetres.

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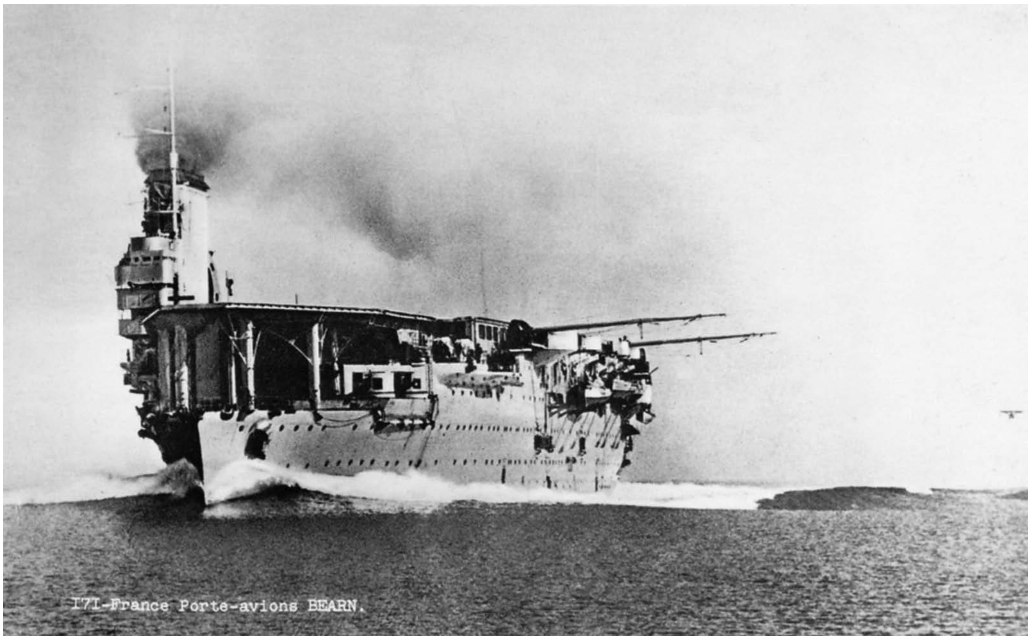
2nd platform deck. As originally conceived they were considered too small and cramped, and were extended while the ship was fitting out by adjusting the position of the bulkheads separating them from the forward 155mm magazines. The ship was completed with two Mle 1923B mechanical computers to handle two separate targets, both housed within the fire control position. However, some of the fire control equipment was delivered late and fitted only after completion.

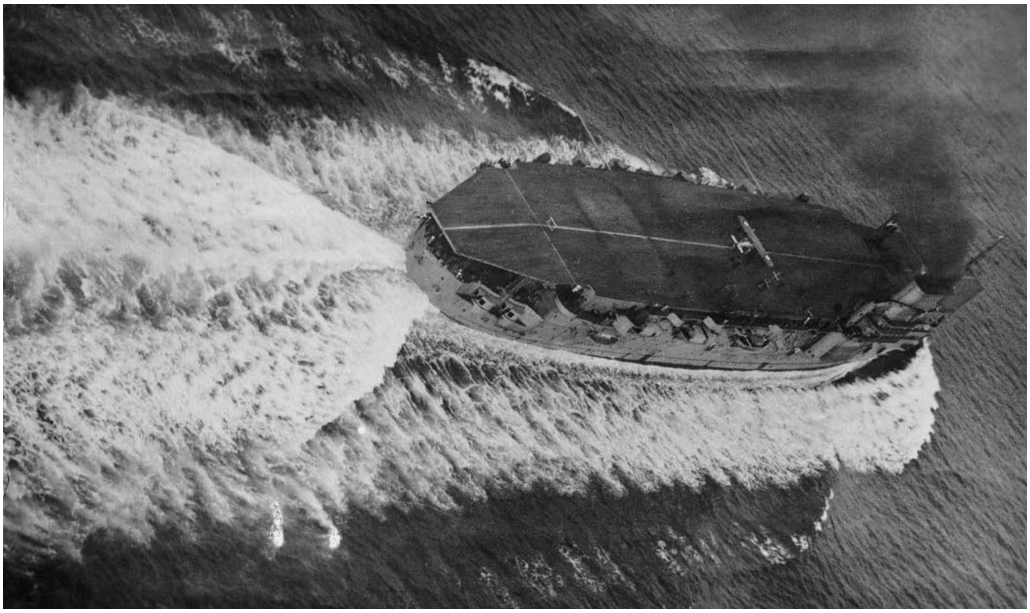
Protection

The *Normandie* class as designed had the classic protection system associated with the distinguished naval architect Emile Bertin: a high, deep belt, with upper and lower armoured decks and a closely-divided cellular layer between. The main belt, which was of face-hardened steel, would have had a maximum thickness of 300mm, reducing at the ends and tapering below the waterline, and was secured by armour bolts to a teak backing. The upper armoured deck (PBS) comprised two layers of 13mm steel plating, and the lower armoured deck (PBI) two layers of 14mm steel, with reinforcing plates of special steel 42mm thick on the slopes for a total thickness of 70mm. The cellular layer comprised an outer cofferdam subdivided into watertight cells each a single frame in length, with coal bunkers inboard to provide additional protection against shells that succeeded in penetrating the belt or the upper armoured deck. The system was designed to prevent large-calibre shell (305mm/12in and above) from reaching the ship's vitals. There would also have been an upper belt of 160mm extending for most of the length of the hull to protect the 14cm casemate battery (see Protection plan).

Such a system was not only unnecessary in a ship designed to resist cruiser and destroyer shell, but it was heavy, accounting for some 30% of displacement, and face-hardened armour was costly. When *Béarn* was taken in hand for conversion, the hull was complete only up to the lower armoured deck. This was retained in its original form, but the thickness of the plates that made up the main deck was reduced from 13mm to 12mm, for a total thickness of 24mm. The main armoured belt was replaced by plates of armour-quality ('special') steel with a uniform thickness of 83mm, secured directly to the hull plating as in contemporary cruisers. It comprised three strakes, not two, and extended from the main deck (PBS) to 3.12 metres beneath the waterline. Not only were the original coal bunkers retained, but they were extended aft so as to provide protection not only for the boiler rooms but for the engine rooms (see GA plans). They were packed with coal that remained in place and was not consumed. As in the original *Normandie* design, there was an inner torpedo bulkhead of 20mm nickel steel (two layers each 10mm thick) lined on the outside by flexible corrugated plating of 10mm mild steel that was designed to act as a spring when exposed to a pressure wave. At its widest point this underwater protection system had a depth of 4.3 metres. However, it was feared that this would not be sufficient to protect against the increasingly large warheads of modern torpedoes, and



Béarn steaming at high speed during her trials in late 1927. The hinged W/T masts to port are in the lowered position; the masts were suppressed in 1928 and replaced by a fixed mast to starboard, abaft the island. (DR)



An overhead of view of *Béarn* on her power trials, steaming at 19.7 knots. (DR)

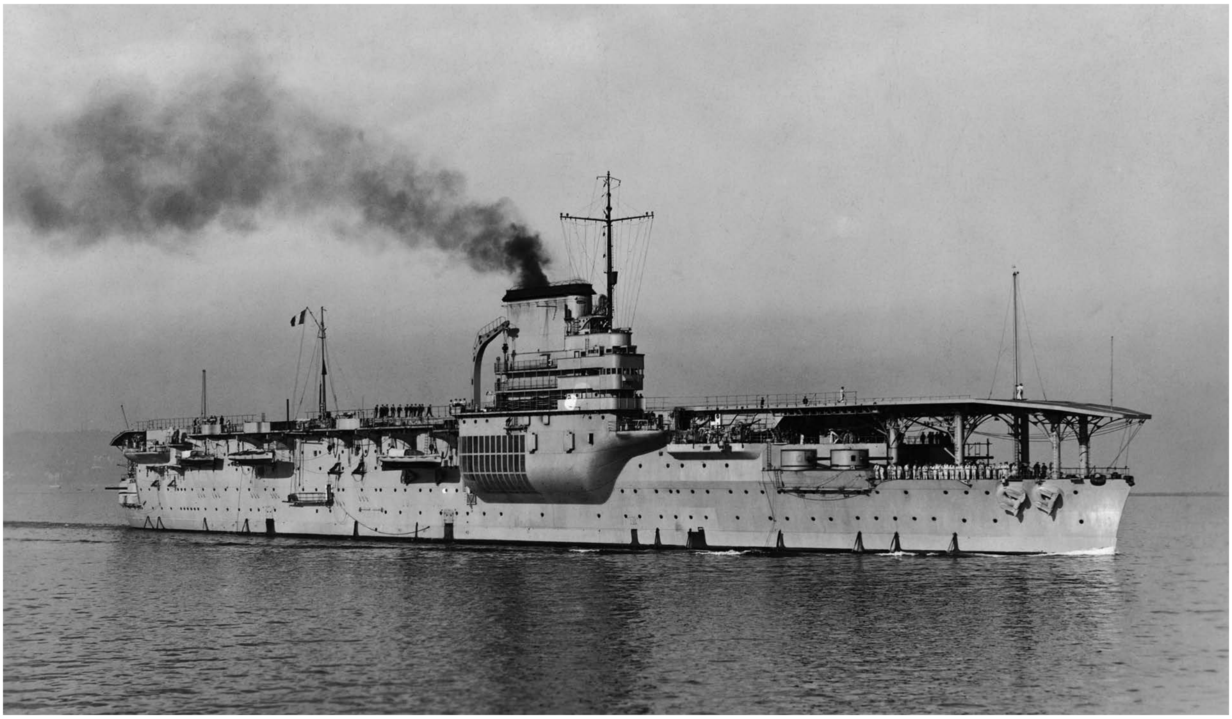
British-style bulges would later be proposed (see below).

The total weight of protection, including the coal, was 5,000 tonnes, which was an impressive figure for an aircraft carrier – the corresponding figure for the battleships of the *Bretagne* class was 7,070 tonnes, although this did not include the 2,000 tonnes of coal in the side bunkers, which would have been burned in the boilers.

Aviation

Having made a detailed study of British carrier developments during the visit of mid-1920, the French opted for a large two-tier hangar topped by a broad flight deck served by three aircraft lifts, with a narrow island to starboard incorporating a large single funnel. The weight of the island had to be compensated by solid ballast comprising 872 tonnes of cemented pig iron in the double bottom to port; this had the additional effect of lowering the centre of gravity and improving stability.

Due to concerns regarding the conning of the ship from the low bridge at the forward end of the island, particularly at night, the design incorporated a retractable charthouse at the forward end of the flight deck, as in the British carriers *Argus* and *Furious*. This could be raised to a height of 5.4 metres above the deck using electric motors – a procedure that took two minutes. There was a *Poste de navigation* on the upper level with a hinged magnetic compass set into the roof, and a sea cabin for the commanding officer directly below; the third level housed the calculating position for the HA guns, the



A fine study of *Béarn* in 1930–31. The flight deck is now sloped 4.5 degrees fore and aft. The 'lamp base' beneath the funnel, with its rows of rectangular air intakes, is particularly prominent. (Private collection)

fourth the lift machinery. Only the upper two levels were ever above deck, and when the lift was in the lowered position there were views forward and to the sides beneath the flight deck. As flying operations at night were not envisaged, there were also retractable masts carrying the main navigation lights on (or close to) the centre-line fore and aft.

The concept of an island was the subject of intense debate in all the major navies during this period. The aviation community generally preferred a clear deck free of any obstruction that might limit wingspan, or fixed structures that might create air turbulence. However, this then posed the problem of how to dispose of the large volume of hot funnel gases generated when the ship was steaming at high speed. It also precluded locating the command spaces necessary for conning the ship and supervising flight operations above the flight deck, hence the adoption of a retractable charthouse in the British *Argus* and *Furious*, both of which had flush decks. As early as October 1918 a narrow island superstructure of wood and canvas had been built at Rosyth and installed to starboard on *Argus*. Trials showed that the island structure produced little turbulence in itself, and that its presence actually helped pilots to orientate themselves when coming in to land. It was subsequently removed from *Argus* in order to maximise the width of the flight deck, but the decision was taken to complete *Hermes* and *Eagle* with islands to starboard, and plans of the latter ship were made available to the French commission in early 1920. In appearance the island adopted for *Béarn* bore a marked visual resemblance to the wood-and-canvas model fitted experimentally in *Argus*, with a single large narrow funnel.

The adoption of an island structure did not erase concerns about the potential turbulence over the flight deck caused by the hot funnel gases, and for *Béarn* the French devised a novel solution. A large streamlined housing (generally referred to in the French Navy as the *cul de lampe* or 'lamp base') was constructed beneath the funnel on the starboard side with rows of large, rectangular air intakes that were connected by ducting to the boiler uptakes. The hot combustion gases were mixed with cold air from outside the ship, thereby reducing the temperature of the gases that emanated from the funnel,[4] and were drawn down onto the after part of the flight deck. This seems to have been reasonably effective, as a second bank of intakes was fitted when the ship was reboilered in 1934–35 (see below).

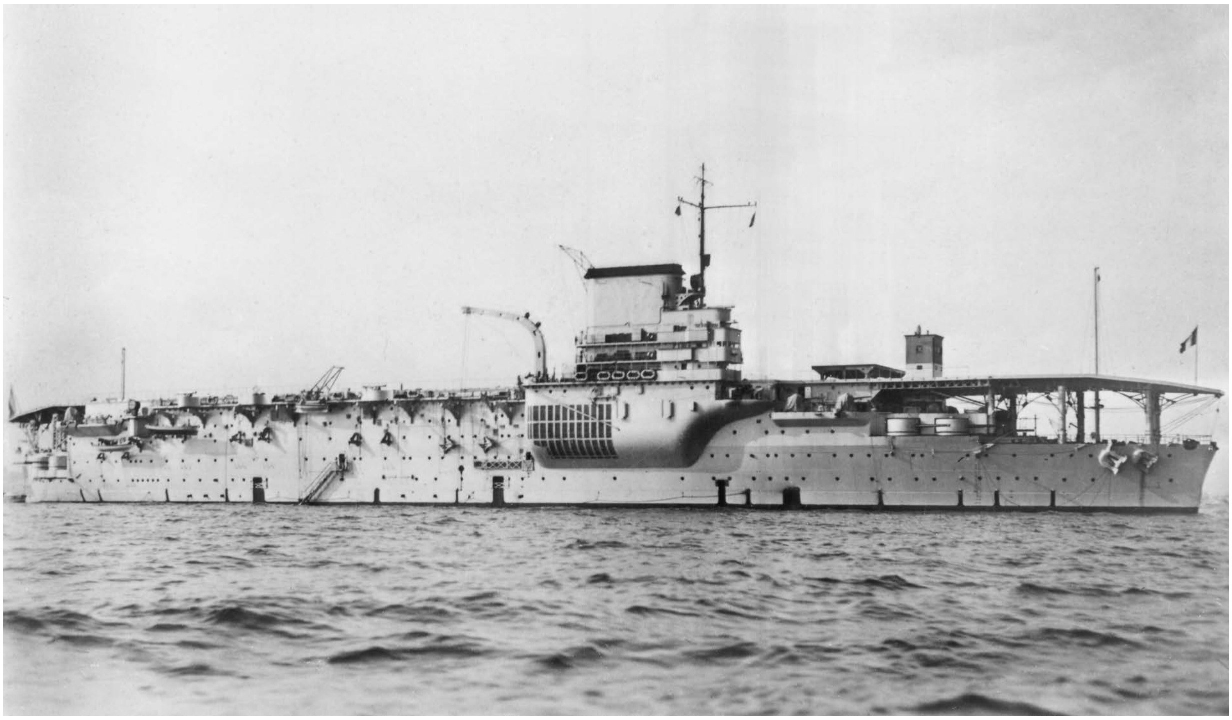
Flight deck

The flight deck was approximately 15.5 metres above the waterline at normal load and was supported on the walls of the hangar amidships and by pillars above the open forecastle and quarterdeck, which were used primarily for line handling and refuelling. It comprised two layers of 12mm steel plating with overlapping plates, topped by wooden planking of African teak (Iroko) with a thickness that varied between 50mm and 70mm. The flight deck was 180 metres long and had a maximum width of 27 metres. The forward section was horizontal when the ship was first completed in 1927, and the after section was angled down at 10 degrees. Following early manoeuvres in which it became clear that it was difficult for the carrier to maintain her station with the fleet when she had to turn into the wind to land aircraft (see below), in December 1928 the forward end of the flight deck was angled down at 4.5 degrees to permit landings over the bow, and in a short refit at the end of the following year the after end of the flight deck was raised to a similar angle. Aircraft used only the horizontal central section of the flight deck for take-off and landing, so the two breaks in the deck were clearly marked by broad transverse white lines. Galleries ran on either side of the flight deck; they were 1.5 metres wide, increasing to 2 metres where the machine guns were located, and punctuated by broader sponsons for the HA guns and rangefinders.

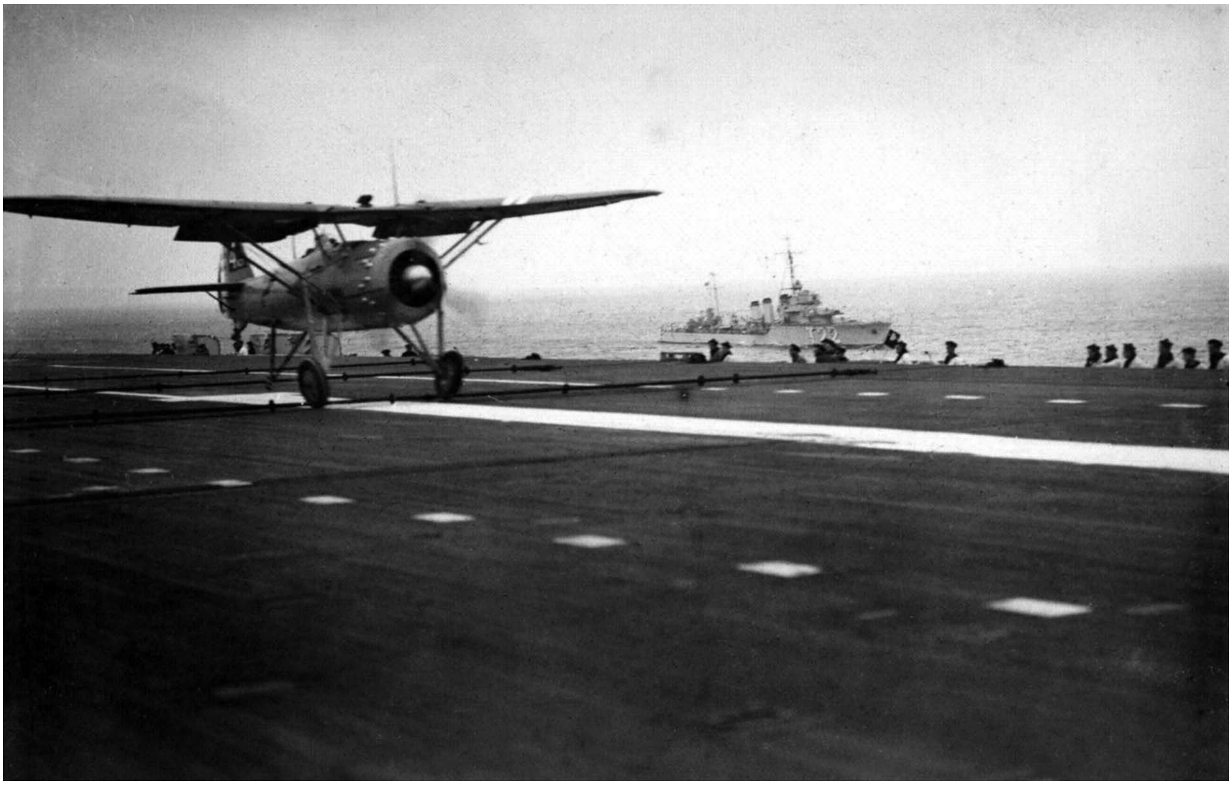
The flight deck and hangar were served by no fewer than three aircraft lifts, each of which was sized for a specific type of aircraft. This was a significant departure from contemporary British practice, which was characterised by a large 'T'-shaped or cruciform lift at the forward end of the hangar able to strike down the largest aircraft with wings deployed, and a narrower lift with a rectangular (or cruciform) configuration aft that could raise aircraft from the hangar ready to be spotted for take-off, possibly with wings folded. Operational doctrine in both navies was to strike down an aircraft directly on landing before the next aircraft landed on, a process that generally took five or six minutes, as the landing interval was dictated by the speed of operation of the lifts; neither navy operated a deck park. For similar reasons the maximum strike that could be spotted for take-off, leaving sufficient length of deck available, was six aircraft, and the Royal Navy 'flight' – the standard unit of organisation – was sized accordingly. French naval air squadrons were generally embarked as two or three sections each of three aircraft, so take-off and landing operations were generally by two sections.

The forward lift on *Béarn*, which was 8 metres long and 12 metres wide, was sized for fighters, and had a 2-tonne capacity; on the 1928 plans of the ship it is labelled 'Ascenseur des A.C.' (A.C. = *avions chasseurs*). Unusually, it was a two-tier lift with the platforms separated by the height of the hangar. In the lowered position the lower platform was at the level of the hangar deck and the upper platform at the level of the flight deck. When the lift was raised to bring up aircraft from the hangar the upper platform was 7.5 metres above the flight deck.[5] A 1931 proposal to extend this lift on its after side by adding a rectangular section 1.5 metres long and 5 metres wide was not proceeded with.

The centre lift was 10 metres long and 15 metres wide, and could therefore accommodate the largest scout bombers of the day (A.R. = *avions de reconnaissance*) with wings deployed. It was complemented by an even larger after lift 15 metres square for torpedo bombers (A.T. = *avions torpilleurs*); both these lifts had a capacity of 5 tonnes. Because these two lifts occupied the centre of the flight deck and were relatively slow in operation – three minutes per complete cycle for the centre lift, a full five minutes for the after lift – the open lift shafts were closed by heavy clamshell doors when the lift was at



Béarn in 1932–34, following the removal of the W/T mast abaft the island, replaced by aerial spreaders secured to the after end of the funnel. The retractable charthouse is in the raised position, and the two-tier aircraft lift immediately abaft it is partially raised. (Musée de la Marine, courtesy of Jean Moulin)



A high-wing monoplane fighter of the Dewoitine D.373/376 series is about to catch one of the Schneider-Fieux arrester wires. The tactical number 'T22' painted on the hull of the destroyer on plane guard duty tells us that the photo was taken in mid-1939 and that the ship is *Frondeur.* (Private collection)

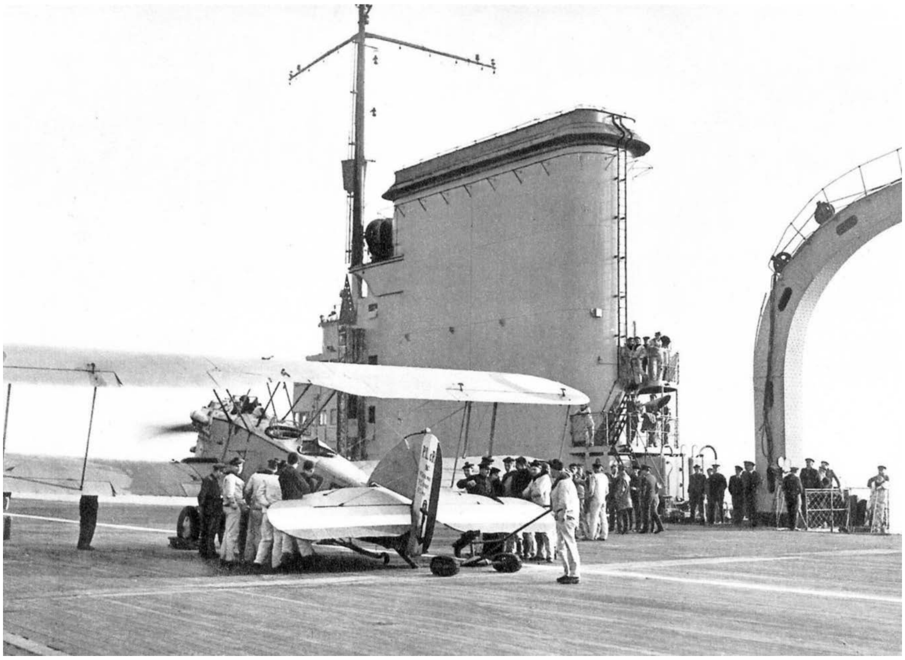
hangar deck level to enable flying operations to continue. Despite the technical ingenuity of this solution, it was costly in terms of topweight and the power required to operate the doors, which required their own electric motors. It was also more vulnerable to breakdown and action damage – although three lifts did offer greater redundancy than two.

All three aircraft lifts and the retractable charthouse were operated by electric motors; large counterweights running in vertical shafts on either side of each lift meant that the power needed to raise the lift was reduced to a minimum. The lifts were designed to operate with a permanent list of 10 degrees, and with a 10-second roll of five degrees. The after lift and the charthouse were specified for six manoeuvres per hour indefinitely, the other two lifts for seventeen consecutive manoeuvres with a 24-hour break, or fourteen consecutive manoeuvres followed by six per hour

Originally there was to have been a palisade similar to those fitted in the early British carriers to prevent the light wood-and-canvas aircraft of the day from being blown over the side on landing. However, this was suppressed by a directive dated 22 April 1925. Instead the French experimented with increasingly sophisticated arrester systems, which by the early 1930s were fully developed.

The first experiments were with five transverse cables strung across the flight deck at intervals of approximately 16 metres, the first of which was 31 metres forward of the 'round-down' across the after lift. The cables were raised 10cm above the deck by circular pieces of cork and weighted down by multiple bags of sand. These were replaced during the first refit of 1928–29 by prototype arrester systems developed by Schneider and Saint-Chamond. The Fieux system manufactured by Schneider worked by friction using restraining drums; the competing Saint-Chamond system used hydraulics. Three cables (two Schneider-Fieux aft, one Saint-Chamond forward) were sited between the after two main aircraft lifts, again at 16-metre intervals (see Profile & Plan). At the same time white stripes were painted 6.5m on either side of the centre-line between the two lifts to mark out the area in which the arrester wires were located; they were later extended forward over the centre lift. The Schneider-Fieux system proved superior, and in a refit late 1932 the Saint-Chamond arrester cable was replaced by a third Schneider model. The pilots who proposed that the forward end of the flight deck be inclined downward also wanted three additional arrester wires between the forward and centre lifts be installed at frames 90, 105 and 120 to permit landings over the bow; however, this measure was not implemented, probably on grounds of cost.[6]

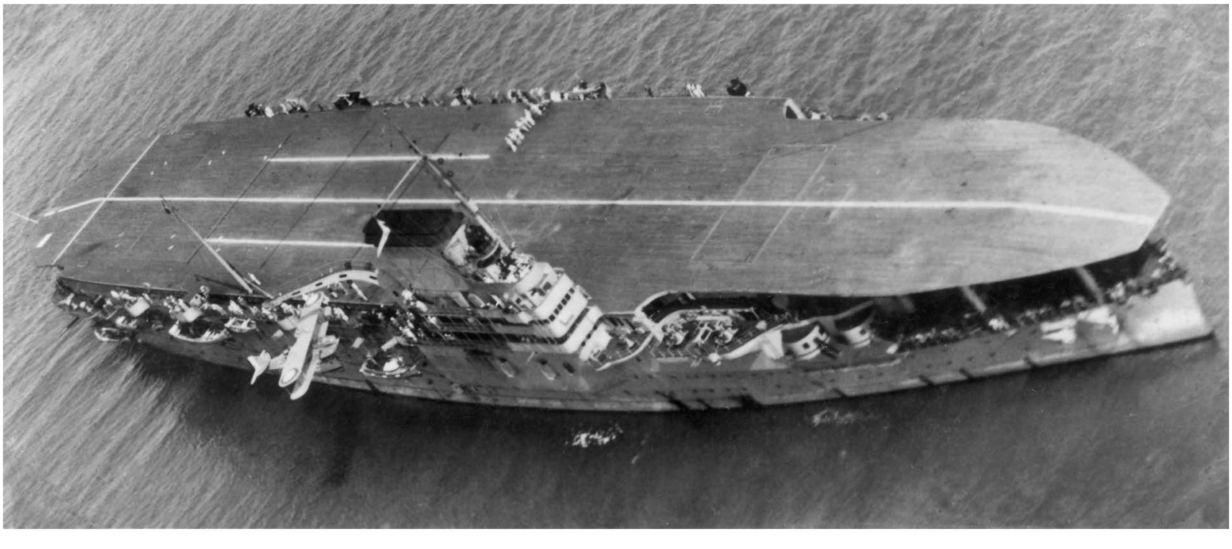
The landing procedure initially adopted was one pioneered by the distinguished French naval aviator Paul Teste. This involved a horizontal approach between



A Levasseur PL.4 reconnaissance aircraft on the flight deck of *Béarn* during the late 1920s. The large 12-tonne crane, which was capable of lifting seaplanes on board, can be seen on the right of the picture. (DR)

50cm and one metre above the flight deck. The pilot used a pylon-mounted sighting arm plus the horizon – or sighting arms fore and aft in conditions of poor visibility – to line up his approach. This required considerable skill and nerve on the part of pilot, particularly when the aircraft passed directly through turbulence abaft the flight deck. A later landing procedure developed by Jean-Julien-Pierre Lartigue, formerly a naval pilot and captain of *Béarn* from 1934, involved an angle of descent of 5–6 degrees, even 10–15 degrees. A single sight comprising a red and white hoop 75cm in diameter, mounted atop a manually-operated hinged mast on the centre-line, had to be aligned with a white rectangle 6m by 2m painted on the flight deck 50 metres farther forward, where the wheels were due to touch down. The angle of approach ensured that the pilot came in above the turbulence and could better assess the pitching of the flight deck. The new procedure, adopted from 1935, reduced landing intervals from six minutes to two/three minutes, although the slow speed of operation of the lifts meant that there was little overall benefit.

Finally, abaft the island, was a large goose-neck crane. Its 12-tonne capacity enabled it to be used not only for embarking and disembarking aircraft when *Béarn* was alongside or from lighters when moored in an anchorage, but to lower and raise seaplanes used for long-range reconnaissance when the ship was in harbour. During the early part of her career, *Béarn* generally operated two CAMS 37A seaplanes in addition to her complement of wheeled aircraft.



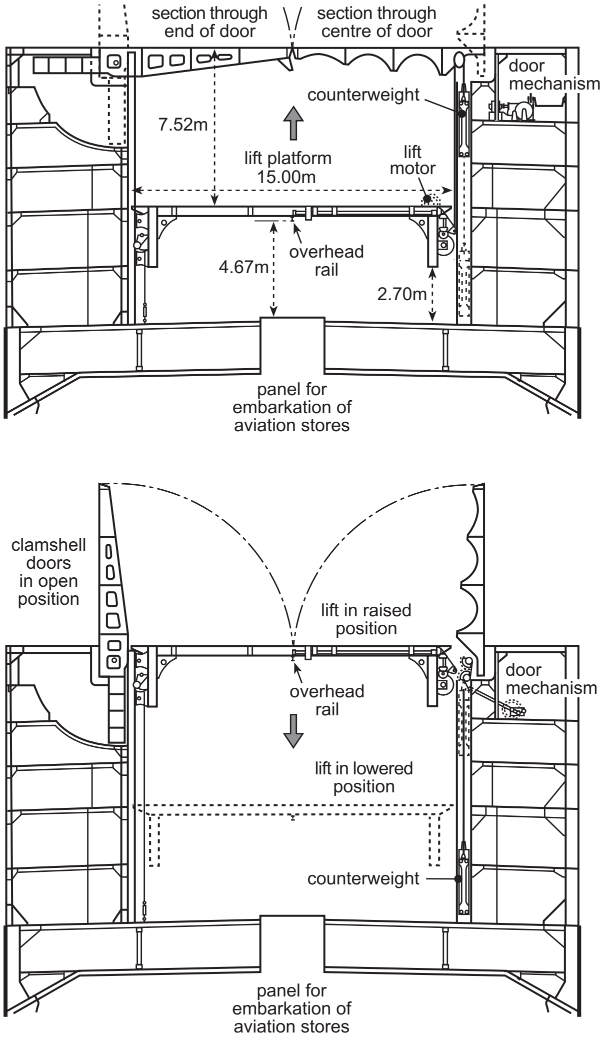
An aerial view of *Béarn* probably dating from 1930–31, prior to the removal of the W/T mast abaft the island. A Levasseur PL.4 reconnaissance aircraft is suspended from the crane. (Musée de la Marine, courtesy of Jean Moulin)

Hangar

Although the French opted for a two-tier hangar on the British model, as in the contemporary *Furious*, *Courageous* and *Glorious*, only the upper hangar, originally referred to as the *entrepont aviation*, was employed for operational aircraft. The lower hangar was divided into two spaces: a repair and assembly workshop aft, and a space for the stowage and assembly of reserve aircraft forward.

Centre Lift

From Fwd



Note: Adapted from plans dated La Seyne 24 December 1928.

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The official plans confirm that, contrary to what has been generally stated in secondary sources, the three aircraft lifts served only the upper hangar. When depicted at this level the lift platform is labelled '*plateforme de l'ascenseur au point bas*' (platform in its lowest position). Also, the run of cable for the counterweight is 7.52 metres, the distance between the hangar deck and the flight deck. The 'feet' at the corners of the lift, and the raised hatched for the embarkation of aviation stores, would in any case have prevented the lift from being lowered to the main deck.

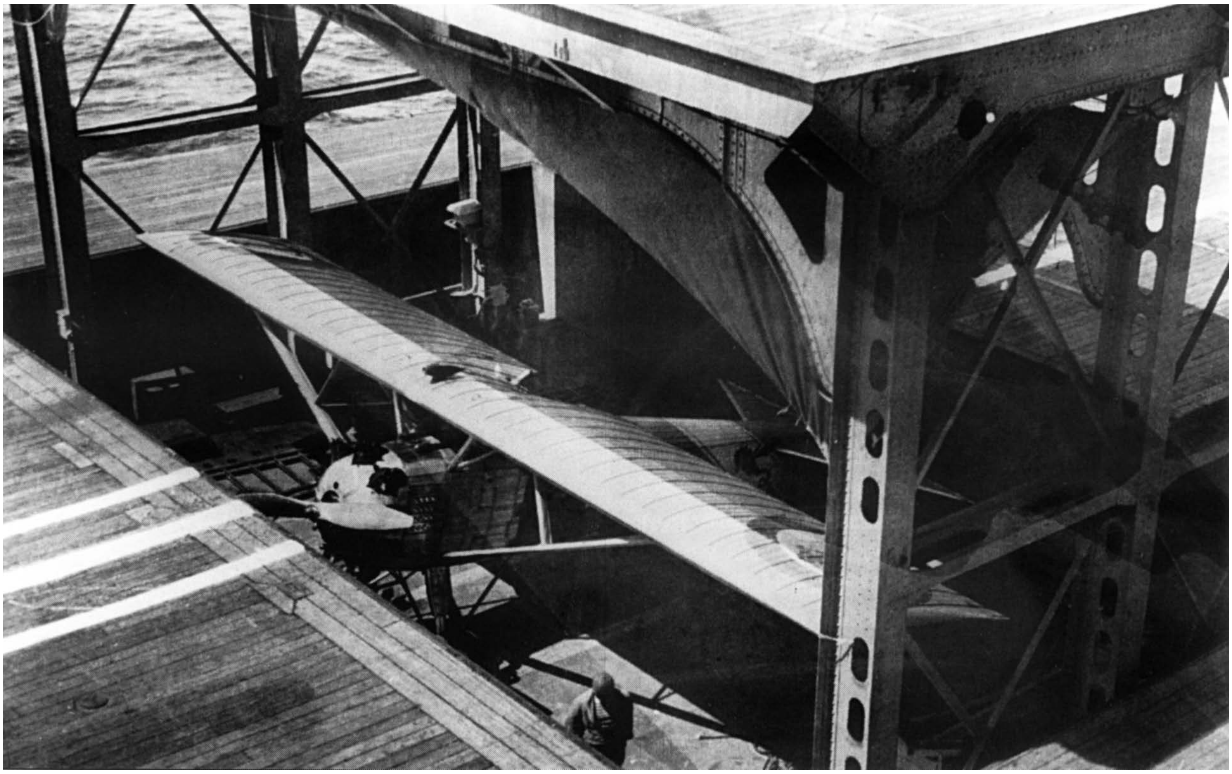
The upper hangar extended from frame 16 to frame 140, with the smaller lift for fighters at its forward end. It was divided into two for the purpose of aircraft stowage, and into four for damage control. The forward section, from F90 (centre lift) to F132, had a gallery deck above to accommodate the air crews. Hangar height was thereby reduced to 5 metres, which meant that it could accommodate fighters and reconnaissance aircraft only; usable length was approximately 42 metres. The after section, from F16 to F80 (centre lift) had 6.5 metres clearance and could therefore accommodate the larger torpedo bombers. Taking into account the after lift, this gave a usable length of 49 metres. The upper hangar had a nominal width of 19.5 metres, but this was reduced to 15 metres – the same width as the centre and after lifts – once the funnel trunking and ventilation, the winches for boat handling and the ready-use racks for air ordnance were taken into account (see Hangar Deck plan).

There were three asbestos fire curtains: one just forward of the after lift, one just abaft the centre lift, and one between the forward and centre lifts. These divided the hangar into four roughly equal sections and (in theory) prevented fire spreading through the hangar.

Aircraft of the day were generally armed and fuelled on the hangar deck, then raised to the flight deck for take-off. There was substantial ready-use stowage for air ordnance to the sides of the upper hangar, between the two after lifts (which handled the reconnaissance and the torpedo attack aircraft) and to starboard of the after lift. There were racks for six large 410kg bombs, six 226kg and six 152kg medium bombs, and six 76kg light bombs to port and to starboard, and for ten 400mm torpedoes to starboard of the lift.

The upper hangar was served by three parallel overhead rails in the form of an I-beam 152mm high and 127mm wide, secured to the underside of the flight deck or the gallery deck; these could accommodate cranes or block and tackle used to move aircraft parts (or even whole aircraft) within the hangar. The rails were broken at the lift shafts and/or the fire curtains. The outer pair of rails was extended aft above the quarterdeck to enable aero engines to be transferred from the hangar to one or other of the test beds above the open stern. The test bed to starboard was for in-line or 'V'-form water-cooled engines; the one to port was for radial air-cooled engines.

The lower hangar was shorter and had compartments to the sides, some of which were employed for accommodation. It extended from Frame 32 to Frame 140, and like the upper hangar had a usable width of approximately 15 metres. The aviation workshop occupied the after end; the remainder of the hangar was an assembly and stowage area for spare aircraft. The hangar was again divided into four by asbestos fire curtains, the location of which mirrored arrangements in the upper hangar. There were large rectangular hatches on the centre-line at the base of each of the three lift shafts for



A Wibault 74 of 7C1 squadron is brought up to the flight deck by the forward aircraft lift in 1933. The forward lift was unusual in having two platforms, and when raised protruded above the flight deck. (Private collection)

the embarkation of aviation stores and ordnance, and smaller hatches for the embarkation of lube oil and aviation fuel offset to port and to starboard, directly above their respective stowage compartments (see below).

Like the upper hangar, the lower hangar was equipped with three parallel overhead rails, secured to the underside of the deckhead. Despite claims in French (and English-language) secondary sources that the three aircraft lifts served both hangars, the plans of *Béarn* show clearly that this was not the case, and that in the lowered position the lifts were at the level of the (upper) hangar deck. A close study of the plans reveals that each of the lifts was fitted with a centre-line rail on its underside that lined up with the axial rails above each of the hangar decks. If an aircraft needed to be transferred between the assembly and repair areas in the lower hangar and the upper hangar, it was suspended from the underside of the lift and raised or lowered accordingly, then moved to the desired location using the overhead rails. This would have been an extremely laborious operation, and makes it clear why the French regarded the upper hangar as the only one capable of actively supporting air operations.

Avgas and oil stowage

Aviation fuel, lubrication oil and petrol for the ship's boats was stored in individual tanks on the 1st platform deck. There were three groups of avgas and petrol tanks: the first two were located in the forward part of the ship and offset to port; the third was close to the stern, directly above the steering gear compartment (see GA plans). Total capacity for the air group was 100,000 litres.[7] These tanks of volatile fuel were all within the armoured citadel, being protected above by the 24mm plating of the main deck, and to the sides by the 83mm belt of nickel steel. Each of the three groups was surrounded by a protective box filled with inert nitrogen gas.

On the same deck level there were multiple tanks holding 15,000 litres of engine oil for the aero engines (aft of amidships, to starboard) and 39,000 litres for the diesel generators (amidships, on either side of the hatch for aviation stores).

The bomb magazines were amidships and aft and were grouped with the aviation store compartments for ease of access. The bomb magazine amidships could accommodate sixty of the large 410kg bombs, while the after magazine complex had stowage for 68 226kg bombs, 132 152kg bombs and 100 76kg bombs (see Machinery plan). The total weight of air ordnance specified was 62 tonnes.

Air Group

A considerable amount of planning and preparation went into the formation of *Béarn*'s first air group under Paul Teste and his successors. Each of the three squadrons was to have a nominal strength of twelve aircraft organised as four 3-plane sections. In 1928 *Béarn* generally deployed with six operational aircraft from each of the three

Béarn Air Group

FighterSquadron

Dewoitine D1

- High-wing monoplane; metallic construction; 40 ordered for Navy.
- 7.5m L x 11.5m W x 2.75m H; 820/1250kg (empty/loaded).
- In service 1925–32.

Wibault 74

- High-wing monoplane; metallic construction; navalised version of Air Force W.72; 24 ordered for Navy.
- 7.6m L x 10.95m W x 2.96m H; 1060/1550kg (empty/loaded).
- Prototype 1929; in service 1932–38.

Dewoitine 373/376

- High-wing monoplane; metallic construction; navalised version of Air Force D.371; 20 ordered for Navy.
- 7.44m L x 11.22m W x 3.42m H; 1295/1860kg (empty/loaded).
- Prototype 1936; in service from 1938; D.376 folding-wing version.

Recce Squadron

Levasseur PL.4

- Single-engine 3-seat biplane with folding wings; seaplane-type hull with floats on wings; recce, observation, bombing; four hard points for bombs; 34 ordered for Navy.
- 9.67m L x 14.60m W x 3.85m H; 1690/2640kg (empty/loaded)
- In service 1927–30.

Levasseur PL.10

- Configuration and missions as PL.4 above; 18 ordered for Navy.
- 9.75m L x 14.20m W x 3.75m H; 1815/2880kg (empty/loaded).
- In service end 1931–33.

Levasseur PL.101

- Modified PL10; 30 ordered for Navy.
- Characteristics as PL.10, but slightly heavier.
- In service 1933–39.

Loire-Nieuport 401

- First French dive-bomber; single-engine gull-wing monoplane; single 225kg bomb; 7 prototypes, then 20 production ordered for Navy.
- 9.75m L x 14m W x 3.5m H; 2135/2820kg (empty/loaded).
- In service from Oct 1939.

Bombing Squadron

Levasseur PL.7

- First aircraft designed to launch torpedoes; single-engine 3-seat sesquiplane with boat-shaped fuselage and folding wings; Mle 26DA 400mm torpedo (670kg) or variable bomb-load using four hard points; 15 pre-series, 30 production models ordered for Navy.
- 11.68m L x 16.50m W x 4.86m H; 2800/3950kg (empty/loaded).
- In service 1930 but returned to factory following accidents 1931; then served until 1939.

Vought 156F

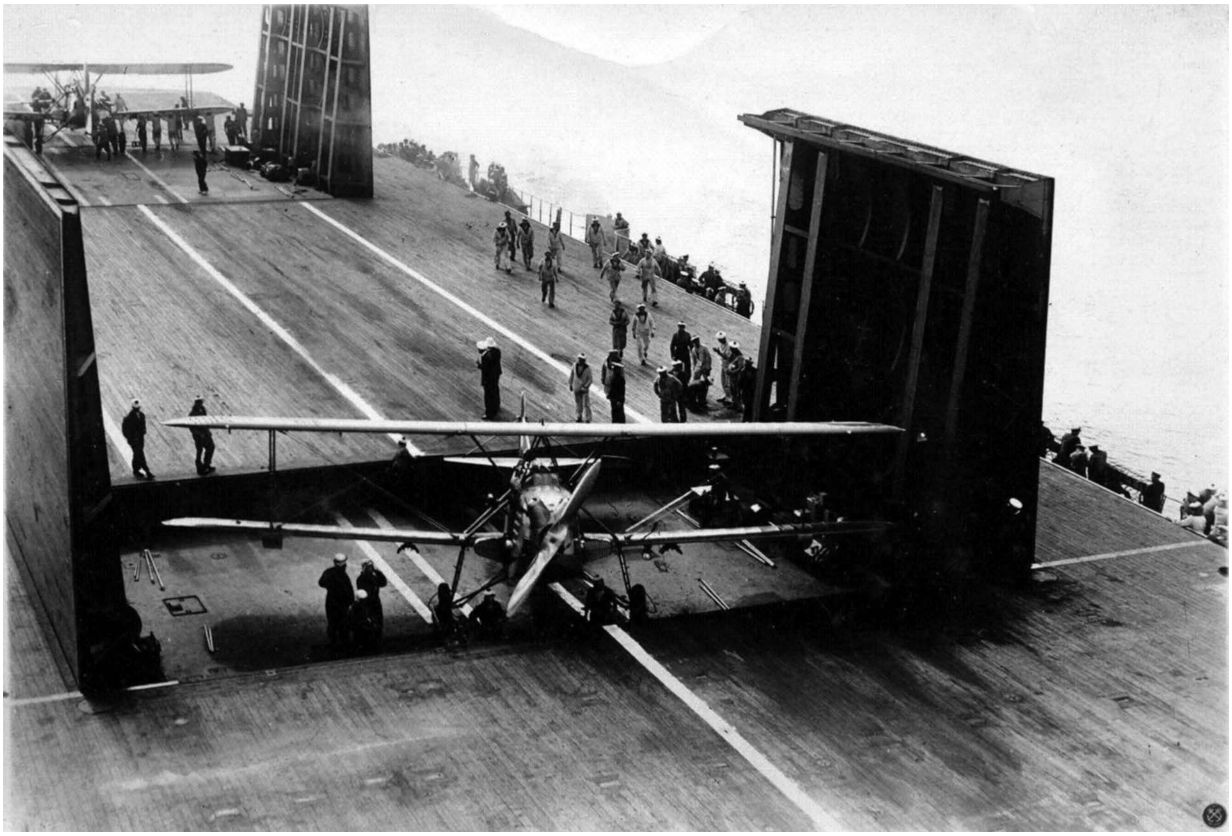
- Export version of SB2U Vindicator; single-engine 2-seat monoplane dive-bomber with variable-pitch propeller & folding wings; three bomb attachment points (one beneath fuselage, one beneath each wing); 40 ordered for Navy; 50 more ordered May 1940.
- 10.33m L x 12.80m W x 4.32m H; 2138/3300kg (empty/loaded).
- In service from September 1939.

squadrons; in 1933 this figure was increased to nine, for a total air group of 27.

By the time *Béarn* entered service in May 1928 the fighter squadron was designated 7C1 (C = *chasseur*). The first aircraft to serve with the squadron was the Dewoitine D1, a small high-wing monoplane of metallic construction with a wingspan of 11.5 metres and a height of 2.75 metres. The D1 proved to be robust; it was superseded in 1932 by the Wibault 74, which had a similar size and configuration and was well-liked by the pilots who flew it. The Wibault 74 was to have been replaced by the Dewoitine 373: a prototype was trialled in 1936, but a series of accidents resulted in the aircraft being returned to the factory for rebuilding, and it did not enter service until 1938. A folding-wing variant, the 376, was then introduced and replaced the 373 in first-line service; a second fighter squadron was formed with the older model shortly before the Second World War – the squadrons were now designated AC1 and AC2 respectively.

The reconnaissance squadron embarked in May 1928 was 7S2 (S = *surveillance*). It was formed initially with the Levasseur PL.4, a single-engine, 3-seat biplane with folding wings and a boat-shaped hull. The PL.4 had a wingspan of 14.6 metres, a height of 3.9 metres and a maximum weight of 2,640kg, and was fitted with four bomb-racks. It was superseded in 1931 by the Levasseur PL.10, which was similar in size, then by the PL.101, a modified PL.10 that served until 1939, when it was due to be replaced by the Loire-Nieuport 401, a single-engine gull-wing dive-bomber that could carry a single 226kg bomb. The latter, however, proved to be under-powered and was never deployed operationally on *Béarn*. The reconnaissance squadron was rechristened AB2 (B = *bombardier*) in 1938.

The attack squadron was initially designated 7B1, and was initially formed with the same PL.4 aircraft that served with the reconnaissance squadron. In 1930 the PL.4 was replaced by the Levasseur PL.7, a large single-engine 3-seat biplane which was the first French aircraft capable of launching a torpedo. It had a wingspan of 16.5 metres (the upper wing had twice the surface area of the lower), a height of 4.86m, and an all-up weight of 3,950kg. The PL.7 could carry either a Mle 26DA 400mm torpedo weighing 670kg, or a variable bomb-load using the four hard points beneath the wings. A serious accident in 1931 that involved the aircraft breaking up in mid-air resulted in the PL.7s being returned to the factory for modification. The aircraft then served until 1939, when it was to have been replaced by the Vought 156F, an export version of the US



Two Levasseur PL.101 reconnaissance aircraft of 7S1 squadron are brought up to the flight deck during the late 1930s using the centre and after lifts. Note the heavy clamshell doors which ensured the flight deck remained in operation when the lifts were lowered to hangar level. (Private collection, courtesy of Philippe Caresse)

Navy's SB2U Vindicator. The first of these were delivered in August 1939 and entered service the following month, but again the aircraft was never operational with *Béarn*. The attack squadron was rechristened AB1 in 1938.

Key data for the all the aircraft described above can be found in the accompanying table.

Anti-aircraft Guns

The anti-aircraft armament of *Béarn* was broadly comparable to that fitted in the contemporary 'treaty' cruisers of the *Duquesne* class.

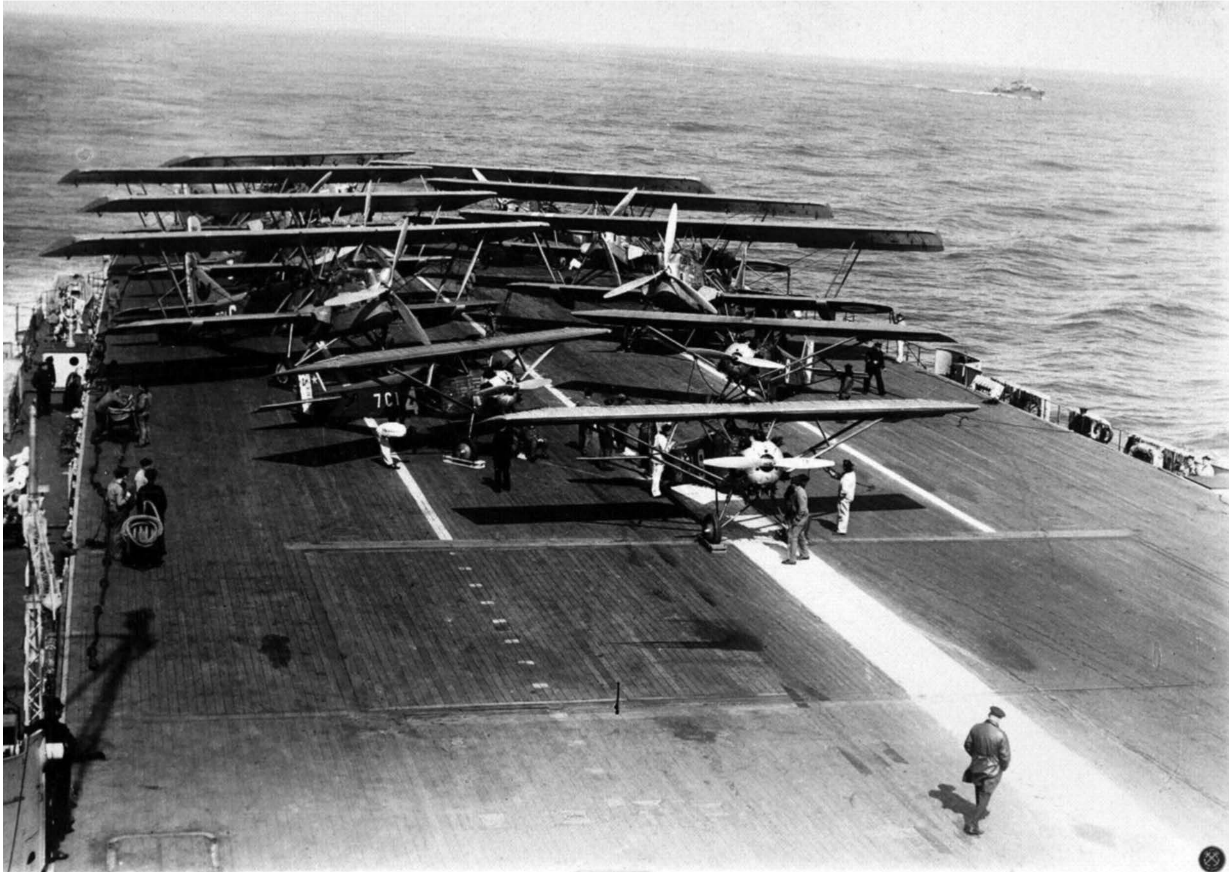
There were four 75mm/50 Mle 1924 guns on sponsons port and starboard at the forward end of the flight deck, and two further mountings aft. They fired a 5.93kg HE time-fused shell designated OEA Mle 1925 or starshell Mle 1923. Provision was 450 fixed rounds per gun, and close to each mounting there was ready-use stowage for 36 rounds in cases of three. Shields were fitted during the 1934–35 reconstruction (see below). Fire control was provided by two of the new HA directors, each of which was fitted with a 3-metre stereo rangefinder from OPL: one in the gallery to port and a second atop the forward end of the island. Due to delays in development and manufacture these were not in place until 1929. They were modified during the 1934–35 reconstruction, when the port-side director was relocated to starboard, beneath the crane.

The light AA initially comprised eight of the new semi-automatic 37mm/50 Mle 1925 guns and twelve 8mm Hotchkiss Mle 1914 machine guns. The 37mm guns, which were in pairs fore and aft, used the same ammunition hoists as the 75mm HA guns. The forward magazine held 352 cases, each containing six fixed rounds, and the after magazine 147, for a total provision of 3.000 rounds (375rpg). There was stowage for 90 ready-use rounds close to each of the mountings.

The 8mm Hotchkiss MG, mounted as four sections of three in the gallery amidships to port and to starboard, proved to be ineffectual against modern aircraft; during the reconstruction of 1934–35 they would be replaced by the new Hotchkiss 13.2mm Mle 1929 gun (see below).

Reconstruction 1934–35

As soon as *Béarn* entered service with the fleet, it became apparent that her comparatively low speed would be an issue. During initial manoeuvres with the battle fleet on 20 July 1928, she altered course to head into the wind while conducting landing operations. After landing two aircraft it took her one and a quarter hours to resume her station steaming at 16 knots, even though the battleships



A view of the flight deck in 1937, with aircraft being ranged for take off. The three aircraft nearest the camera are Wibault 74 fighters of 7C1 squadron; behind them are ranged the six Levasseur PL.7 torpedo bombers of 7B1. At the after end of the flight deck is a PL.101 reconnaissance biplane – probably the one assigned to the air group commander. (Private collection)

were cruising at only 12 knots. This led to the request from the pilots for the modifications to enable them to land over the bow outlined above.

In January 1931, less than three years after her entry into service, the ship was immobilised due to jamming of the clamshell doors of the centre lift and the poor state of her boilers, and in October the STCN was instructed to undertake a study for a major reconstruction to include:

- replacement of the boilers
- modifications to the forward lift
- replacement of the 75mm guns by the new 100mm CA being fitted in the aviation transport *Commandant Teste*.

Further studies were requested to determine the feasibility and cost of:

- replacement of the original propulsion machinery by geared turbines
- the fitting of anti-torpedo bulges
- enhanced protection of the decks to protect the ship against the increasing threat from land-based bombers.

Estimates were for immobilisation between twelve months and three/four years, depending on the extent of the works; the cost would be between 33 million and 125 million francs (possibly rising to 200m FF). It was estimated that geared turbines would supply 60,000CV – an increase of 50 per cent – for a top speed of 23.4 knots. However, if bulges were fitted maximum speed would be reduced by more than one knot (22.3 knots).[8] Displacement would rise by about 500 tonnes.

The project was abandoned in part due to the age of the hull – 20 years from laying down by January 1934. Maximum speed would still have been only 22–23 knots – the new fast battleship *Dunkerque* had a designed speed of 29 knots – and it would not be possible to upgrade protection against aerial bombing. In the event the Minister approved only a limited reconstruction costing 25 million francs, of which 17m FF was for reboilering. This took place at La Seyne and Toulon between February 1934 and November 1935 and included the following work:

- replacement of the original boilers by six of the new standard Navy-type du Temple small-tube boilers (three per boiler room)
- a second bank of vents in the *cul de lampe* that increased air volume by 50%

A Levasseur PL.101 takes off during the late 1930s; the PL.101 could be distinguished from the PL.10 by the absence of an axletree as part of the undercarriage. *Béarn* is being escorted by destroyers of the *Bourrasque* and *L'Adroit* classes. (Private collection)

– removal of the retractable charthouse and the 550mm torpedo tubes
– replacement of the 8mm machine guns by six twin 13.2mm Hotchkiss Mle 1929 AA, mounted to port and to starboard on either side of the after aircraft lift
– modifications to the HA directors, and new-model rangefinders for the main and the light AA guns in the gallery to port and to starboard.

During her post-refit trials, on 26 Aug 1935 *Béarn* attained an average speed of 20.8 knots on the course off the Hyères islands (east of Toulon) – 20.38 knots in the face of a strong *Mistral*, 21.25 knots in the opposite direction– with five boilers lit.

Following her reconstruction she was redeployed to Brest, arriving in early October 1936. Too slow to operate with the modern cruisers based at Toulon, she was to provide aerial reconnaissance for the elderly battleships of the 2nd Battle Division (*Bretagne* class). However, when the latter returned to the Mediterranean in the spring of 1939 *Béarn* remained at Brest. Following the outbreak of war her air group was disembarked, and she was subsequently relegated to the training role, conducting landing qualification trials off the south of France with the latest Vought 156F dive-bomber due to enter service with the Navy. During May and June 1940 she was employed to transport gold to the USA and to bring back the aircraft purchased with it. When the Armistice was concluded on 25 June she was immobilised at Fort-de-France in the French Antilles.

Sources:

Moulin, Jean, Morareau, Lucien & Picard, Claude, *Le Béarn et le Commandant Teste*, Marines édition (Bourg-en-Bresse, 1997).

Official plans dated La Seyne 24 December 1928, held by the Centre d'Archives de l'Armement, Châtellerault.

Endnotes:

[1] *British Aircraft Carriers*, Seaforth Publishing (Barnsley 2013), 66.

[2] The 6in guns for *Hermes* were subsequently replaced by 5.5in (140mm) guns from the discarded cruiser *Birkenhead*, and the three quarterdeck mountings were suppressed to enable the ship to operate seaplanes.

[3] The figure of 70mm given by Campbell in *Naval Weapons of World War Two* probably includes a double layer of 10mm steel to which the special steel plating would have been secured.

[4] Similar measures were adopted by some navies during the late 20th century to prevent SSMs with infra-red guidance from locking on to the hot funnel gases.

[5] The after lift in the IJN carriers *Akagi* and *Kaga* was similar.

[6] Forward arresting gear was fitted in all US carriers during the 1930s.

[7] By way of comparison, the French carrier *Clemenceau*, completed in 1961, could stow 1.6 million litres of aviation fuel.

[8] The bulges would have had a depth of 2.70 metres on either side of the lower hull. They would have increased beam to 32.4 metres – the maximum that could be accommodated in the available dry docks.

THE EIGHT-EIGHT FLEET AND THE *TOSA* TRIALS

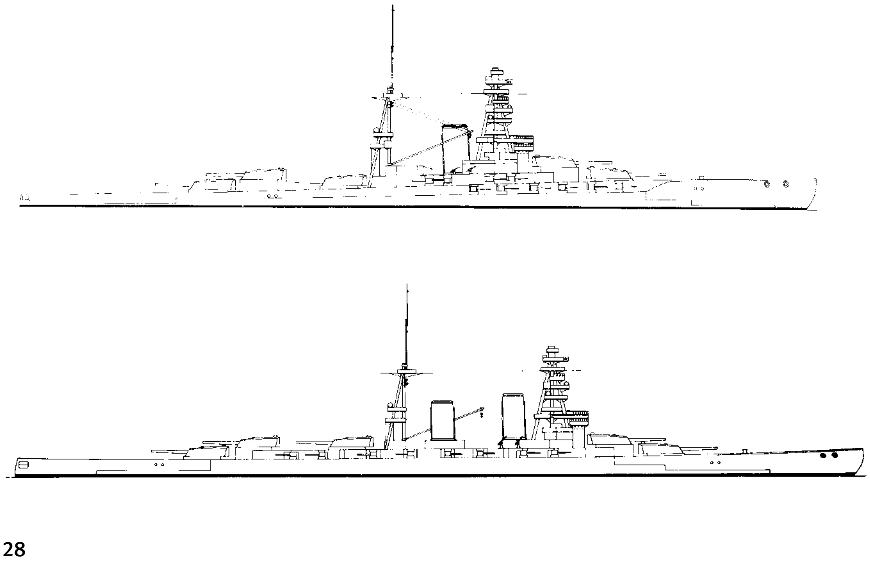
The principles behind Japan's Six-Six Fleet were explored in *Warship* 2019. In this follow-up article on the Eight-Eight Fleet, **Hans Lengerer** looks at the ambitious plans for the projection of Japanese naval power during the second decade of the 20th century.

The IJN's programme for a fleet of eight battleships and eight armoured cruisers ('battle cruisers' from 1912) as the core of two fleets, subsequently known as the 'Eight-Eight Fleet', was authorised by the emperor in April 1907 as part a new national defence strategy.[1] Considered the minimum naval force necessary to implement this strategy, the ships had to be of the most modern types and all were to be less than eight year old.[2]

The rapid pace of technological progress and tactical developments compelled the Imperial Japanese Navy (IJN) constantly to revise the definition of the term 'most modern'. The dreadnought type would be superseded by the 'super-dreadnought' type, and by the latter stages of the programme all capital ships were to be of the 'post-Jutland' type. Each time the definition changed, the ships laid down before the revision no longer met the standard and had to be replaced by the new type. This on-going process reinforced the pressure on national finances and, moreover, slowed the realisation of the programme.

Contrary to the situation after the Sino-Japanese War (SJW), when the larger part of the Chinese reparation payment was used to build the Six-Six Fleet, Russia had to pay no reparations following Russo-Japanese War (RJW). Moreover, the cost of the RJW far exceeded that of the SJW and placed Japan's national finances in extreme difficulty. Because of this the IJN agreed not to request an increase in naval expenditures between 1906 and 1909. However, following lengthy studies, the Naval General Staff (NGS) was anxious to realise the Eight-Eight Fleet in a single step, and in May 1910 requested the building of twelve new battleships and eight new battle cruisers. Financing such a large programme proved to be out of the question, and the NGS had to accept a reduction of 75 per cent – only one battleship and four battle cruisers were authorised. In 1911 the Navy requested seven battleships and two battle cruisers, but this request was reduced by one third and the content of all naval programmes decided before the approval of national defence policy was adjusted.

Rivalry between the IJN and the IJA to obtain budgets for their respective expansion heightened the pressure upon governments and national finances. Confronted with this situation, in November 1912 the third Katsura Tarō Cabinet declared the establishment of a National Defence Conference to harmonise the planning of both services. Set up in June 1914, the Defence Conference proposed in October the creation of an Eight-Four Fleet by the end of FY 1921 as the first step on the path to the Eight-Eight Fleet: the first part of the Eight-Four Fleet Completion Programme was to be implemented in September 1915, with the other part postponed until 1917. The budget for the first *tranche* was duly approved by the 37th session of the Diet in February 1916. Known as the Eight-Four Preparation Programme, it allowed the



Profiles of the battleship *Tosa* and the battle cruiser *Amagi*, both designed post-Jutland by Hiraga to form part of the Eight-Eight Fleet. Both types would have displaced around 40,000 tons and mounted ten 16in (41cm) 45-calibre guns in twin turrets. They had a new protection system which featured an inclined belt and a British-style anti-torpedo bulge; the secondary battery of 5.5in (14cm) guns would have been unprotected, as in the latest US Navy battleships. The battle cruisers were 20 metres longer and would have had 45 per cent greater horsepower, giving them a designed speed of 30 knots. (*CAWFS* 1906–1921)

Table 1: **Towards an 8-8 Fleet**

Six-Six (Six) Fleet	**Four-Four-(Four) Fleet**	**Six-Four-(Four) Fleet**	**Four-Four-(Ten/Eight) Fleet**
SJW to RJW: 1896–1905	Post-RJW to end of Meiji [1] era (1906–1912)	End of 1912 (after the decision to form the 8-8 Flt with Super-Dreadnought Types)	1915–1920 (until authorisation of the 8-8 Flt completion program and decision to form this fleet with Post-Jutland Types)
Preparation of the IJN for the RJW	First Interim Battle Fleet (Pre-Dreadnought Types)	Second Interim Battle Fleet (Semi-Dreadnought and Pre-Dreadnought Types)	Third Interim Battle Fleet[2] (Super-Dreadnought Types)[3]
BBs *Fuji, Yashima, Shikishima, Hatsuse, Asahi, Mikasa* ACs *Asama, Tokiwa, Yakumo, Azuma, Izumo, Iwate*	BBs *Kashima, Katori, Satsuma, Aki* ACs *Tsukuba, Ikoma, Kurama, Ibuki*	BBs *Settsu, Kawachi, Satsuma, Aki, Kashima, Katori* BCs *Tsukuba, Ikoma, Kurama, Ibuki*	BBs *Fusō, Yamashiro, Ise, Hyūga* BCs *Kongō, Hiei, Kirishima, Haruna*
To this first-line fleet were added six elderly vessels: *Fusō* (I), *Chin'en*, *Matsushima* class as a second-line fleet	To this first-line fleet were added the four old BBs *Fuji*, *Shikishima*, *Asahi*, *Mikasa* as a second-line fleet[4]	To this first-line fleet were added the four old BBs *Fuji*, *Shikishima*, *Asahi*, *Mikasa* as a second-line fleet	To this first-line fleet the were added the ships of the Second Interim Fleet of the preceding period (minus *Tsukuba* in 1917 and *Kawachi* in 1918)[5]

Notes:

1 The periods stated above are not absolute because the ships were built and commissioned successively. Generally speaking, the ships of the first and the succeeding interim fleets were to form part of the next until the completion of the respective ships of the Eight-Eight Fleet. The decision that this fleet should comprise the 'most modern' types resulted in the change from the standard to the Dreadnought type, then to the Super-Dreadnought type, and eventually to the Post-Jutland type. The change in the types, in combination with the limitation on the age of the ships which were to make up the battle (first) line, resulted in the construction of considerably more replacement ships than would otherwise have been necessary.

2 The Third Interim Fleet comprised the ships decided by the Defence Conference on 7 October 1914 as belonging to the Eight-Four Fleet, as the first stage of the Eight-Eight Fleet.

3 After Jutland, and the subsequent decision to form the Eight-Eight Fleet with only Post-Jutland capital ship types, the Super-Dreadnought ships of the Third Interim Fleet were to be transferred to the second line as soon as the replacement ships were commissioned

4 The captured (or salvaged and repaired) ex-Russian battleships and armoured cruisers whose fighting power was less than *Mikasa* – explanation of Navy Minister Saitō Makoto in the Cabinet meeting of 28 September 1906 in reference to the 'youngest' Russian war prizes *Sagami* (ex-*Peresviet*) and *Iwami* (ex-*Orel*) – are excluded.

5 In the first revision of national defence policy (authorised by the emperor on 29 June 1918), the naval power requirement was increased to the Eight-Eight-Eight Fleet standard. However, the building of the extra fleet of eight Post-Jutland capital ships was never incorporated in a building programme.

construction of the battleship *Nagato* to supplement the four battleships of the *Fusō* and *Ise* classes and the four battle cruisers of the *Kongō* class, which the National Defence Conference had recognised in 1914 as capital ships belonging to the Eight-Eight Fleet.

In 1916 an extraordinarily large naval expansion programme was approved by the US Congress. A total of 156 warships, including ten battleships and six battle cruisers, were to be laid down over the next three years. The first *tranche* of this programme, which aimed to make the USA the world's largest naval power,[3] was authorised in 1917. When the entire programme was complete the US Navy's superiority over the IJN would be 100 per cent.

The effect of this development on naval expansion in Japan was dramatic. Supported by the war boom that had followed the economic depression in the first months of the Great War and the revolution in Russia – following which an attack by the traditional first hypothetical enemy of the IJA could be excluded – the Eight-Four Fleet Completion Programme was approved by the 39th extraordinary session of the Diet in July 1917: it included three battleships (*Mutsu, Kaga, Tosa*) and two battle cruisers (*Amagi* and *Akagi* as replacement ships for battle cruisers *Kongō* and *Hiei*). In March 1918 the Eight-Six Fleet Completion Programme was approved by the 40th session of Diet, adding the battle cruisers *Atago* and *Takao*. The budget of the Eight-Eight Fleet Completion Programme was submitted to the 42nd session of the Diet and approved by the Lower House in February 1920, but the Diet was dismissed. Re-submitted to the 43rd extraordinary Diet session, it was approved in July 1920 and was promulgated on 1 August. In order to ensure that the Eight-Eight Fleet comprised only post-Jutland type capital ships the Navy was allowed to build four battleships (*Kii, Owari, Suruga, Omi*) and four battle

Table 2: **IJN Capital Ships Current and Planned**

Name	No in Budget	No as Super-Dreadnought	No as Post-Jutland Type Dreadnought	Running no in 8-8 Fleet
Fusō (II) */**	3	1	–	–
Yamashiro */**	4	2	–	–
Ise */**	5	3	–	–
Hyūga */**	6	4	–	–
Nagato */**/***	–	5	1	1
Mutsu */**/***	–	6	2	2
Kaga */**/***	–	7	3	3
Tosa */**/***	–	8	4	4
Kii ***	–	–	5	5
Owari ***	–	–	6	6
Suruga ***	–	–	7	7
Omi ***	–	–	8	8
Kongō (II) *	I Gō	1	–	–
Hiei (II) *	Bō Gō	–	–	–
Haruna *	2	2	–	–
Kirishima *	3	3	–	–
Amagi (II) **/***	–	–	4	9
Akagi (II) **/***	–	–	5	10
Takao (II) **/***	–	–	6	11
Atago (II) **/***	–	–	7	12
No 13 Type ***	–	–	8–11	13–16

Notes: * = 8-4 Fleet; ** = 8-6 Fleet; * = 8-8 Fleet**

cruisers (Nos 8–11 of the No 13 class); pre-Jutland type ships were excluded, except for battleships No 1 (*Nagato*) and No 2 (*Mutsu*).

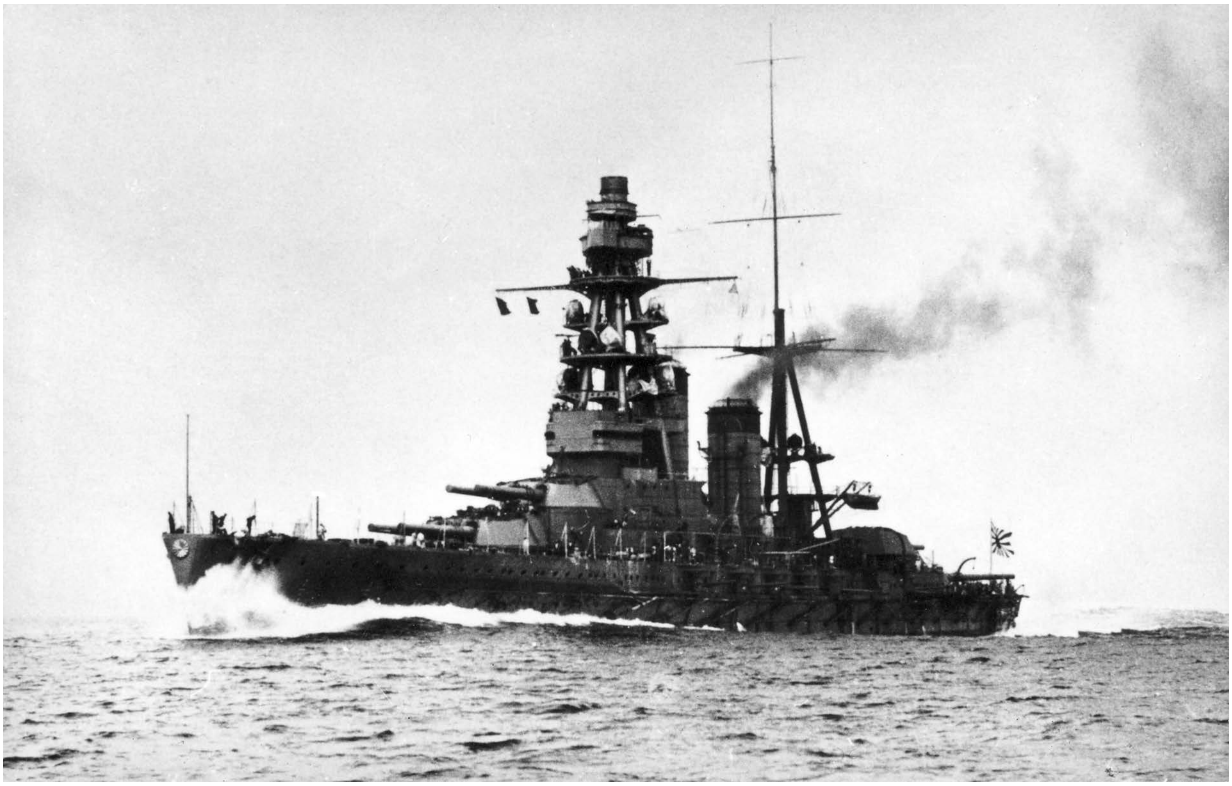
This fleet was to be operational by the end of March 1928, when the IJN's battle force – *ie* the ships less than eight years old – was to comprise 16 capital ships (8 battleships + 8 battle cruisers), 22 cruisers, *c*75 destroyers, *c*80 submarines and the corresponding number of auxiliaries. However, even after a period of 22 years this would constitute only a partial success, because in June 1918, in the first revision of the National Defence Policy, the IJN had expanded the minimum necessary forces to an Eight-Eight-Eight Fleet in order to confront the massive expansion of the US Navy.

The rapid authorisation of successive naval expansion programmes with steadily increasing budgets reinforced the pressure upon the national finances. Inflation, together with the cost involved in upgrading ships already designed and under construction to the state of the art, elevated the pressure still further. In addition to the expenditure on new-build construction, huge sums of money were required for the maintenance and the replenishment of warships, and for the expansion of the naval dockyards and training establishments (see below). This became a major concern for the financial experts, who prophesied a collapse of the Japanese economy should the Eight-Eight Fleet programme go ahead. Moreover, the budgetary situation was aggravated by the postwar depression following the boom years of the war.

After the Great War, with its heavy loss of life and damage to infrastructure, calls for disarmament became strong. The successful conclusion of an arms limitation treaty by the League of Nations seemed to be unobtainable; and no alternative to the continuation of the ruinous naval race was in sight. This then was the backdrop to the US proposal for a conference between the major powers to discuss naval arms limitation as well as the strategic situation in the Pacific and Southeast Asia. The invitation to the conference provoked conflicting opinions in Japan. Some saw it as a potential blow to Japanese prestige and political ambitions,[4] others as a 'divine wind' which would rescue Japan from financial collapse.[5] Premier Hara Kei and Navy Minister Katō Tomosaburō inclined towards the latter view.

The Washington Conference, which began on 12 November 1921, concluded on 6 February 1922 with the signing of the Washington Naval Arms Limitation Treaty by the representatives of the USA, Britain, Japan, France and Italy. The key clauses were those which established a 5:5:3 ratio in capital ships for Britain, the USA and Japan combined with a ten-year 'holiday' in capital ship construction with a view to ending the ruinous naval arms race. The clause restricting the IJN to 60 per cent of capital ship tonnage compared to the US and Royal Navies, rather than the 70 per cent ratio considered essential for Japan's national security, brought about frustration and anger in naval circles. The Eight-Eight Fleet was reduced at a stroke to a Six-Four fleet composed principally of dated (*ie* pre-Jutland) ships.

The IJN moved from expansion to reduction to prevent financial ruin. However, the treaty could not altogether suppress naval competition, which shifted to the 'auxiliary' category, principally the 10,000-ton 8in-gun cruiser and torpedo forces, and strategic and tactical concepts



Despite the decision that the Eight-Eight Fleet was to comprise only 'Post-Jutland' ships, the pre-Jutland sisters *Nagato* and *Mutsu* became battleships nos 1 & 2 of this fleet. The controversy regarding *Mutsu*'s stage of completion at the Washington Conference is well known. This is *Nagato* running her trials in Sukumo Bay on 27 October 1920. (Courtesy of Lars Ahlberg)

were revised accordingly. Modernisation was carried out to prolong the active life of the existing battleships and battle cruisers, and Japan fought the Pacific War with capital ships which would have been obsolete at the end of the 1920s by the standards of the Eight-Eight Fleet.

The Eight-Eight Fleet: Preparatory Stages and Final Composition

A common feature between the Six-Six(-Six) and the Eight-Eight(-Eight) Fleets as envisaged by Navy Minister Yamamoto Gonnohyōe was the planned implementation in stages. As it would have been impossible to fund the third component of the fleet it was to be made up of ships belonging to the 'second period age' (*Kanrei* = ship age; *dai ni ki* = second period). Table 1 (page 29) shows the composition envisaged.

Table 2 lists the capital ships in accordance with their age classification. It confirms that the Eight-Eight Fleet was to be formed only with post-Jutland capital ships except for *Nagato* and *Mutsu*.

The Prohibitive Cost of the Eight-Eight Fleet

An account of the development of the armament supplement expenses (*Gunbi Hojū Hi*) from FY 1911 onwards, which illustrates the dramatic rise in inflation and the relationship between national finances and military expenditure, makes it clear that the Japanese economy would have collapsed before the realisation of the Eight-Eight Fleet Completion Programme.

The armament supplement expenses were formed by the combination of *Gunkan Seizō Hi oyobi Kenchiku Hi*, *Kantei Hosoku Hi*, *Seibi H*i and *Hojū Kantei Hi*, of which a total of ¥166,450,411 (of the original authorised budgets totalling ¥352,085,846) remained. To this amount ¥82,223,170 were added (for a total of ¥434,309,016), meaning that a sum of ¥248,673,581 was available for spending over the six financial years FY 1911 to FY 1916. Table 3 (overleaf) lists the sums allocated to naval expenditure in these and subsequent years. Table 4 (overleaf) shows the dramatic rise in naval expenditure as a proportion of the national finances, beginning with FY 1907, the year in which the first National Defence Policy was decided. Between FY 1917 and FY 1921 it rose from 15.24 per cent to 31.55 per cent.

The effect of naval expansion upon the national finances was acknowledged by the IJN. In the course of planning for the Eight-Eight Fleet Completion Programme the Navy Ministry had calculated overall costs as approximately ¥600,000,000.[6] A further calculation showed a rise in military expenditure from 48 per cent in FY 1921 to 60 percent of the national budget in FY 1923. In other words, the Eight-Eight Fleet could not be built and maintained without a dramatic increase in the national finances, while further expansion to an Eight-Eight-Eight fleet was out of the question. In addition, since the rate of inflation and other influences upon the economy (and on costings) could not be forecast with any degree of certainty, even this huge sum might be insufficient.

In this situation, Navy Minister Katō summoned his deputy, Vice Admiral Ide Kenji, and the heads of the Naval Affairs Bureau and the NTD to his official residence for secret talks in April 1921. He explained that the situation had become critical due to a dramatic change in the viewpoint of members of the Diet and in public opinion. Support for the IJN's ambitions had now given way to concerns regarding building and maintenance expenditure. He explained that Japan's GDP had simply not grown in relation to naval expenditure. After declaring 'we cannot proceed at the current pace', he confessed: '… I am at my wit's end'.[7] Around the same time Deputy Finance Minister Nishihara Hajime briefed Navy Minister Katō and 60 assembled high-ranking Navy officers on the present state of Japan's financial position, which was '… fast becoming hopeless', and appealed to them: '… whether or not it will collapse is entirely up to you.'[8]

The Infrastructure Planned to Support the Eight-Eight Fleet

After the Russo-Japanese War ¥45 million were authorised to expand naval facilities, and the Naval Building

Table 3: **Budgetary Planning**

Fiscal Year	Budget approved	Added due to inflation	Remarks
1912	¥248,673,581		Armament Supplement Expenses established in FY 1911 and formed by the combination of four budget items. Expenses for FY 1912 to FY 1916.
1913	¥6,000,000		To begin construction of battleships *Yamashiro*, *Ise*, *Hyūga*.
1914	¥6,526,000		To continue construction of battleships *Yamashiro*, *Ise*, *Hyūga*.
1915	¥93,946,914		Prolongation until FY 1918.
1916	¥43,230,899[1]		Eight-Four Fleet Preparation Programme, authorisation of *Nagato*, prolongation until FY 1919.
1917	¥261,521,160	¥6,322,682	Eight-Four Fleet Completion Programme, authorisation of battleships *Mutsu*, *Kaga*, *Tosa* and battlecruisers *Amagi* and *Akagi*, prolongation until FY 1923; declared total amount ¥659,898,554.
1918	¥300,548,437	¥30,534,405[2]	Eight-Six Fleet Completion Programme, authorisation of battle cruisers *Takao* and *Atago*; total amount ¥915,933,880.[3]
1919	¥52,050,950[2]		
1920	¥761,112,152[4]	¥37,066,705 (¥80,752,097)	Eight-Eight Fleet Completion Programme, authorisation of four battleships of the *Kii* class and four battle cruisers of the No 13 type, prolongation until FY 1927; declared total amount ¥1,765,945,127.
1921		¥105,050,112[5]	Declared total amount ¥1,847,454,823, spending to FY 1921 ¥1,040,658,080; total allocation for FY 1922 until FY 1927 ¥806,796,743.6

Source: *Kaigun Gunbi Enkaku*, Vol 1, Section III, 'After the Russo-Japanese War up to 1921', Chapters 21–44. According to *Senshi sōsho* Vol 31, 'Naval Armament Preparations' (*Kaigun Gunsenbi*) Vol 1, 746, the total sum authorised by the 27th Diet session for FY 1911 was ¥158,308,417. This accords with *Kaigun* (Navy), Vol XIV, 228, listing Warship Building Expenses (*Kantei Seizō Hi*) from FY 1911 up to FY 1941.

Notes:

1 The request was for ¥45,327,819, but this amount was reduced to ¥43,230,899 by subtracting money as yet unused or saved.
2 The combined total for FY 1918 and FY 1919 amounted to ¥104,841,975, but the author has been unable to find the respective figures.
3 This figure should have been ¥960,446,991, but ¥44,513,111 were transferred to *Junbi Gunji Hi*.
4 In addition, the budget authorised included ¥80,752,097 due to inflation.
5 Added to the annual expenses for FY 1921 of ¥168,251,247, giving a total of ¥273,301,359(!)
6 The total corrected amount of Armament Supplement Expenses (*Gunbi Hojū Hi*) would have been ¥1,944,010, but in FY 1918 the Water & Land Facilities Expenses (*Suiriku Setsubi Hi* = ¥35,939,254) were separated and the Shipbuilding & Weapon Production and Repair Expenses (*Zōsen, Zōhei oyobi Shuri Hi*) were transferred to Armament Military Commodities Expenses (*Gunbi Gunjuhin Hi* = ¥60,616,121).

Note the dramatic increase in inflation after 1917. While in the three Fiscal Years 1917–1919 the total budget was ¥111,164,657, between Fiscal Years 1920 and 1921 it rose to ¥274,919,864. The data show that the budgets authorised were insufficient to fund the programmes envisaged, and would have required a major increase every year. According to *Senshi sōsho* Vol 31 'Naval Armament Preparations' (*Kaigun Gunsenbi*) Vol 1, 741, the price index (based on the 1900 figure of 100) rose to 154.6 in 1916 and 343.2 in 1920 (an increase of 222 per cent!), falling back to 263.5 in 1923.

Works Section (*Kenchika*) established in 1885; this was expanded to the Temporary Naval Building Works Division (*Kenchikubu*) in 1896 with a branch at Maizuru. In 1920 it was elevated to the Naval Building Works HQ (*Kenchikihonbu*), and was charged with preparations for the building, fitting-out and port facilities for the Eight-Eight Fleet. Dr Yoshimura Chisaku, a civil engineer specialist, was the first head of the now-independent organisation. In the Naval Stations (*Chinjufu*), Building Divisions headed by engineers were organised and put under the command of the respective C-in-Cs. However, following the signing of the Washington Naval Arms Limitation Treaty, the organisation was dissolved in March 1923 and its scale much reduced.

With regard to building docks, the construction or expansion of Yokosuka Nos 5 & 6, Kure No 4, Sasebo No 7 and Ominato No 1 had been planned, but these programmes were either cancelled or reduced after Washington. Yokosuka No 5 dock was completed in

Table 4: **Naval Expenditure as a Proportion of the National Budget**

Fiscal Year	**National Finances (Yen)**	**Naval Expenditures Amount (Yen)**	**Per cent**	**Total Military Expenditures Amount (Yen)**	**Per cent**
1907	635,889,000	82,482,000	12.97	194,099,000	30.52
1908	626,788,000	80,961,000	12.92	190,378,000	30.37
1909	520,472,000	72,189,000	13.86	161,554,000	30.78
1910	548,250,000	75,722,000	13.81	163,219,000	29.72
1911	573,996,000	87,005,000	15.15	167,330,000	32.64
1912	582,040,000	93,810,000	16.11	189,794,000	32.61
1913	594,416,000	97,357,000	16.37	195,852,000	32.94
1914	668,235,000	103,963,000	15.55	199,225,000	29.81
1915	750,678,000	106,084,000	14.13	203,924,000	27.17
1916	602,262,000	102,243,000	16.97	196,557,000	32.64
1917	780,170,000	118,916,000	15.24	222,466,000	28.52
1918	902,373,000	184,735,000	20.47	304,194,000	33.71
1919	1,064,190,000	249,548,000	23.44	394,283,000	37.04
1920	1,504,755,000	398,811,000	26.50	631,492,000	41.97
1921	1,591,286,000	502,124,000	31.55	765,387,000	48.10
1922	1,501,485,000	397,406,000	26.46	654,721,000	43.46
1923	1,389,353,000	278,692,000	20.09	483,781,000	34,82

Source: Kaigun Yūshūkai (Ed), *Kinsei Teikoku Kaigun shiyō* (A Basic History of the Imperial Japanese Navy in Modern Times), 225–26. There are differences in the statistics used by J Charles Schencking in his *Making Waves; Politics, Propaganda, and the Emergence of the Imperial Japanese Navy, 1868–1922*, 186 and 217, but these are not significant. The budget table for 1891–1940) in *Kaigun* (Navy) Vol XIV, 250, differs slightly because the temporary war expenses (from FY 1914 to FY 1925) are given separately.

Notes:

1 Until FY 1914 naval expenditure was between 13 per cent and 16 per cent of the national finances and insufficient for expansion.

2 From FY 1914 to FY 1923 naval expenditure increasingly surpassed expenditure on the IJA. After that there was again a relative decrease.

3 Note the effect of the war boom upon the national finances. Without this influence the naval budget could not have been expanded as it was; on the other hand, it served to increase inflation.

4 The increase in naval expenditure in FY 1920 and FY 1921 was dramatic, rising to almost one third of the national finances. While in FY 1920 *c*42 per cent of the national finances were allocated to military expenditure, in FY 1921 this figure rose to 48 per cent. It would have exceeded this figure had the Eight-Eight Fleet programme been realised.

5 The annual shipbuilding expenses for FY 1921 were ¥168,251,247 as stated above (to which ¥105,050,112 were added due to inflation for a total of ¥273,301,359); the total naval expenditure was ¥502,124,000. In the course of the realisation of the Eight-Eight Fleet, ordinary naval expenditures (general account) would gradually increase due to the additional expenses implied by the increase in personal and training establishments, expansion of naval facilities, support for civil heavy industry and other industrial branches related to shipbuilding, the maintenance and replenishment of warships, and the improvement of military ports.

6 The success of Navy Minister Katō Tomosaburō in securing approval for the budget for the realisation of the Eight-Eight Fleet was made possible because the number one hypothetical enemy of the IJA, Russia, ceased to be a threat due to the revolution and because of the 'extraordinary peace' with Germany. On the other hand, the USA accelerated the expansion of its navy and aimed to surpass even the Royal Navy in overall strength. With the IJA's long-term potential enemy gone and the huge expansion of the USN, the IJN's foremost hypothetical enemy, naval expansion to attain the minimum necessary forces was recognised as the priority. Consequently, the budget ratios of the IJA and IJN were reversed in favour of the IJN, and the IJA lacked effective arguments to prevent this. Also, party policy and the lobbying of the IJN was apparently more effective than that of the IJA (see Ian Gow, JC Schencking and also Asada Sadao.)

Admiral Katō Tomosaburō. He promoted the Eight-Eight Fleet as Navy Minister by fighting for the necessary funding, but recognised even before the beginning of the Washington Naval Arms Limitation Conference that Japan simply lacked the resources and the national finances to complete the programme. His behaviour at that conference was that of a statesman rather than a military man and was greatly appreciated by the representatives of the other countries. When he returned from Washington he attempted to implement a reorganisation which would permit greater civilian control over the Navy, but was opposed by the 'younger Katō' (Hiroharu) and supporters of the 'fleet faction'. He died soon after becoming Premier without carrying out his planned reforms. His health was affected not only by the bitter struggles with the 'fleet faction', but also by the burden of dual posts and responsibilities. (Courtesy of Lars Ahlberg)

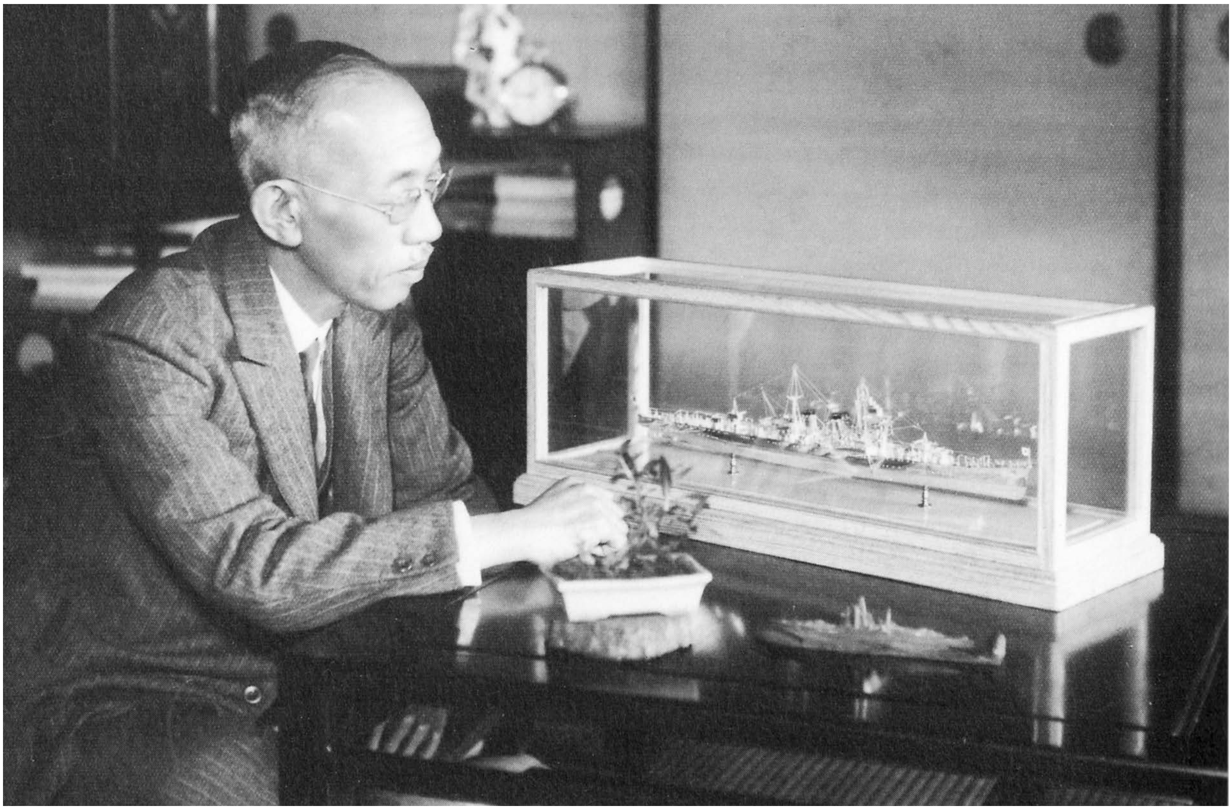
Hiraga Yuzuru is probably the best-known Japanese naval architect outside Japan, and was the chief designer of the capital ships of the Eight-Eight Fleet. He executed the basic designs for all except the last four ships quickly, and some ships, including *Kaga* and *Tosa*, were even launched by the time the Washington Naval Arms Limitation Treaty was concluded. Hiraga was also responsible for modifications to the design of the battleship *Nagato* which took into account the lessons of Jutland, but was unable to realise his '*Mutsu kai*' design because of time pressure. (Courtesy of Lars Ahlberg)

March 1918 and lengthened from 1923 onwards; Kure No 4 was completed in April 1931 as one of the largest building docks in the world, Yokosuka No 6 in May 1940 and Ominato No 1 in April 1944; Sasebo No 7 was not built.[9]

Naval Architect Hiraga Yuzuru

The battleships *Nagato* and *Mutsu* were the ships slated for the Eight-Eight Fleet which were designed prior to Jutland; in the event, they were also the only capital ships of the IJN's 'dream fleet' to be completed following the conclusion of the Washington Treaty.[10] Japanese authors almost all refer to Vice Admiral Hiraga Yuzuru as the designer. In a lecture in the presence of the Crown Prince, the later Shōwa Tennō, on 18 December 1924, Hiraga declared: '… I have been in the business of designing the warships and was the chief designer of the *Nagato*, *Kaga*, *Kii* and *Amagi* classes, the carriers *Kaga* and *Akagi* and the cruisers of the *Yūbari*, *Furutaka*, *Myōkō* types …' However, a closer study of Hiraga's service with the IJN reveals that Hiraga was not the designer of the *Nagato* class. It is perhaps ironical that Japan's best-known naval architect, and the chief designer of all the post-Jutland capital ships of the Eight-Eight Fleet, was not the designer of the only two completed ships, even though he was responsible for revisions to the protection system (known as the 'concentrated protection method' – a Japanese version of the US Navy's 'all-or-nothing' principle) and speed (an increase in horsepower by one third, to 80,000shp) after Jutland.

Lieutenant (engineer) Hiraga joined the Naval Technical Department (NTD) on 3 February 1909 and was assigned the following day to the Third Division



Another portrait of Hiraga Yuzuru. He was a mathematical genius and often surprised others with his mental arithmetic. He could also be stubborn: he resisted the requirements of the Naval General Staff with well-reasoned argument, leading to his ultimate dismissal from the post of chief designer; his later Japanese nickname was *Yuzurazu* (= 'gives no way'). Following his return from a tour of warship builders in Europe and the USA, he became head of the shipbuilding research division of the Naval Technical Research Institute (NTRI) on 3 June 1925. On 31 July 1929 he submitted a proposal for a ship to replace *Kongō* (Design 'X') to the chairman of the Higher Technical Conference, Kobayashi Seizō, in opposition to the design of the chief designer of the NTD, Fujimoto Kikuo. Such a move was unprecedented, and Hiraga's critique of Fujimoto's design (referred to by insiders as the '*Kongō* Replacement Ship Debate Case') disclosed not only personal differences with his successor as chief designer but also his frustration about his enforced transfer from the NTD to the NTRI. On 30 July 1932 he became a professor at Tōkyō Imperial University, holding the post until 31 March 1938. His paper 'Experimental Investigations into the Resistance of Long Plates and Ships' was based on his research at the NTRI. It was read on 11 July 1934 at the summer meeting of the Institute of Naval Architects and was awarded the gold medal. He attended the Higher Technical Conference (Chairman: Katō Hiroharu) convened to discuss planning for the *Yamato* class on 19 October 1935, and assisted chief designer Fukuda Keiji in the design of the battleships as adviser of the NTD from 1 April 1935. His design philosophy is clearly expressed in these giant battleships. (Courtesy of Lars Ahlberg)

(Shipbuilding). The head of the division was Fukuda Umanosuke, the father of Fukuda Keiji, famous as the chief designer of the 'super-battleships' of the *Yamato* class. Hiraga was involved in the preliminary design of the two battleships of the *Fusō* class. On 5 August 1912 he became a member of the Shipbuilding Department of Yokosuka Naval Dockyard. On 26 August he was appointed head of the drawing office, and on 10 June 1913 he added the role of head of the shipbuilding office, performing both functions in tandem.

He relinquished these roles on 7 April 1916, when he was again transferred to the NTD (then *Kaigun Gijutsu Honbu*) as superintendent of shipbuilding on 15 May. He was assigned to the Fourth Division (Shipbuilding) with Fukuda Umanosuke as division head and Asaoka Mitsutoshi as head of the Preliminary Design Section. From that time he was in charge of the preliminary design of the capital ships of the Eight-Eight Fleet. The battleship *Nagato* had been ordered from Kure NY on 12 May 1916, three days before Hiraga moved to the NTD, so it is clear that Hiraga was not the designer of the *Nagato* class.

On 31 May/1 Jun 1916 the Battle of Jutland was fought, and on 11 August[11] Hiraga, who was a member of the Temporary Investigation Committee, submitted a modified design for the battleship *Nagato* (A 114) which took into account the lessons of the battle, and this was approved by the Navy Minister on 28 October 1916. These modifications, which primarily concerned speed and protection, were made in a hurry.

After that Hiraga worked on a large number of designs for high-speed battleships and battle cruisers, all of which featured inclined side armour and 16in guns, the number being increased from eight to ten from preliminary design A 119 onwards. In January 1917 he became a member of the Investigation Committee into the loss of the battle cruiser *Tsukuba* to a magazine explosion; the chairman was Rear Admiral Katō Hiroharu, otherwise known as Katō Kanji, and the report was submitted on 23 July. Hiraga was promoted Captain on 1 April 1917 and proposed the so-called 'Revised *Mutsu* design' (A 125) with inclined belt armour on 12 June 1917; this, however, was rejected.

Yamamoto Kaizō graduated as a naval architect from Tōkyō Imperial University, and entered the IJN immediately as *Zōsen shōgishi* (corresponding to lieutenant constructor rank). He was posted to the UK from 1898 to 1902, becoming a member of the 4th Division (Shipbuilding) of the NTD on his return, and was Hiraga's predecessor as chief designer before his promotion to head of the division on 1 December 1920. As chief designer he was Hiraga's superior during the period when the capital ships of the Eight-Eight Fleet were designed, and when Yamamoto was promoted Hiraga became chief designer on the same day. He retired in 1923 at the age of 56 and died in 1958. From October 1922 to November 1925 he was the fourth president of The Society of Naval Architects in Japan and published a paper entitled 'Twenty-Five Year Development of the Imperial Warships' in the April 1923 issue of the society's magazine. He disliked publicity, and tended to give the credit for his own achievements to his subordinates. After his retirement he backed the designs of Fujimoto Kikuo. His support for the latter when he was head of the Cruiser Section (*Junyōkanhanchō*) is said to have influenced his retirement from all official functions following the *Tomozuru* Incident. (Courtesy of Lars Ahlberg)

On 14 July 1917 the budget for the Eight-Four Fleet was approved by the Diet. On 26 July the former head of the Preliminary Design Section, Asaoka Mitsutoshi,[12] became head of the Fourth Division, and Yamamoto Kaizō took over his former post and function.

On 1 Dec 1920 Yamamoto was promoted head of the Fourth Division and Captain Hiraga was appointed head of the Preliminary Design Section. He was promoted Rear Admiral on 1 June 1922, dismissed from his post on 1 October 1923, and despatched on a visit to Europe and the USA to investigate the shipbuilding situation after the conclusion of the Washington Treaty. His dismissal was triggered by disagreements with the NGS over the fitting of torpedo tubes in the new 'treaty cruisers' of the *Myōkō* class; however, this was not the only instance of Hiraga's resistance to staff requirements he considered unrealistic or unwise.

Prior to Hiraga's departure, on 13 Aug 1923, Vice Admiral Yamamoto had been replaced as head of the Fourth Division of the NTD by Suzuki Keiji. The post of head of the Preliminary Design Section was therefore the highest achieved by Hiraga, who had ambitions to lead the Third or the Fourth Division; it is reported that this was his greatest regret in life.

One question remains. If Hiraga was not the chief designer of the *Nagato* class, then who was responsible for these battleships, which differed greatly from their predecessors? The obvious conclusion is that the initial design of *Nagato* was the work of Yamamoto Kaizō, under the direction of Asaoka Mitsutoshi, and was completed in 1915, the year prior to the order to begin construction.

The *Tosa* Trials: Protection System

Kaga and *Tosa* were the first IJN battleships designed to incorporate the lessons of Jutland. The protection for the main gun turrets and magazines was enhanced, the underwater and horizontal protection were reinforced, and there was direct protection for the boiler uptakes. At the same time the design team took into account the results of the systematic trials of armour protection recently carried out, and also evaluated the protective arrangements of the most modern capital ships of the Royal and US Navies in so far as reliable data were available. The principle of concentrated and collective protection was further stepped up while attempting to keep weight increases to a minimum.

Inclined hull side armour was adopted for the first time. The angle of inclination of the 11in (279mm) Vickers cemented (VC) armour plates, the thickness of which was reduced by 1in compared to *Nagato*, was 15 degrees. It therefore offered greater resistance against AP shells fired at greater range and striking with a higher angle of obliquity. The upper edge of the armour was connected to the middle deck (which was the main armour deck), and the lower edge was 6 feet (1.83m) below the design waterline.

Table 5: **Specifications of Armour and Protection**

Armour (VC except *VNC)

Side belt:	
amidships (15° inclined)	11in (279mm)
fore and aft (15° inclined)	10in (254mm)
Bulkheads:	
fwd end of side belt	10in (254mm)
forward	10in (254mm)
after end of side belt	9–10in (229–254mm)
Barbettes:	
above main deck	12–9in (305–229mm)
between main & middle decks	3–2in (76–51mm)*
Conning Tower:	
walls	14–10in (356–254mm)
roof	7in (178mm)
floor	3in (76mm)
Communications tube	5–3in (127–76mm)*
Funnel & machinery spaces ventilation	9–5in (229–127mm)
Main deck	2.5in (63mm)*
Middle deck, forward	2.5in (63mm)*

Protective Plating (HTS except *VNC)

Middle deck, above machinery spaces	1.5in (38mm)
Middle deck, above magazines	2.5in (63mm)
Middle deck, slopes	3in (76mm)
Lower deck, forward (in lieu of 280mm side armour)	1–0.75in (25–19mm)
Middle deck, aft	2–0.75in (51–19mm)
Lower deck, forward	4*–2.75in (102–70mm)
Magazines:	
crowns	1in (25mm)
sides	0.5in (12.7mm)
Torpedo bulkheads:	
side	3in (76mm)
transverse	4–2in (102–51mm)
Pressure bulkhead boiler room	0.75–0.5in (19–12.7mm)
Splinter bulkheads:	
middle deck	1.25–0.5in (32–12.7mm)
a/w torpedo tubes	0.75in (19mm)
between 14cm guns	1in (25mm)
below lower deck fwd end side belt	1.5–0.75in (38–19mm)
Mast & control platform	2.75–1in (70–25mm)
Dividing/transverse bk/hds steering compt	1.5–0.5in (38–12.7mm)
After steering position	0.75in (19mm)

Key:

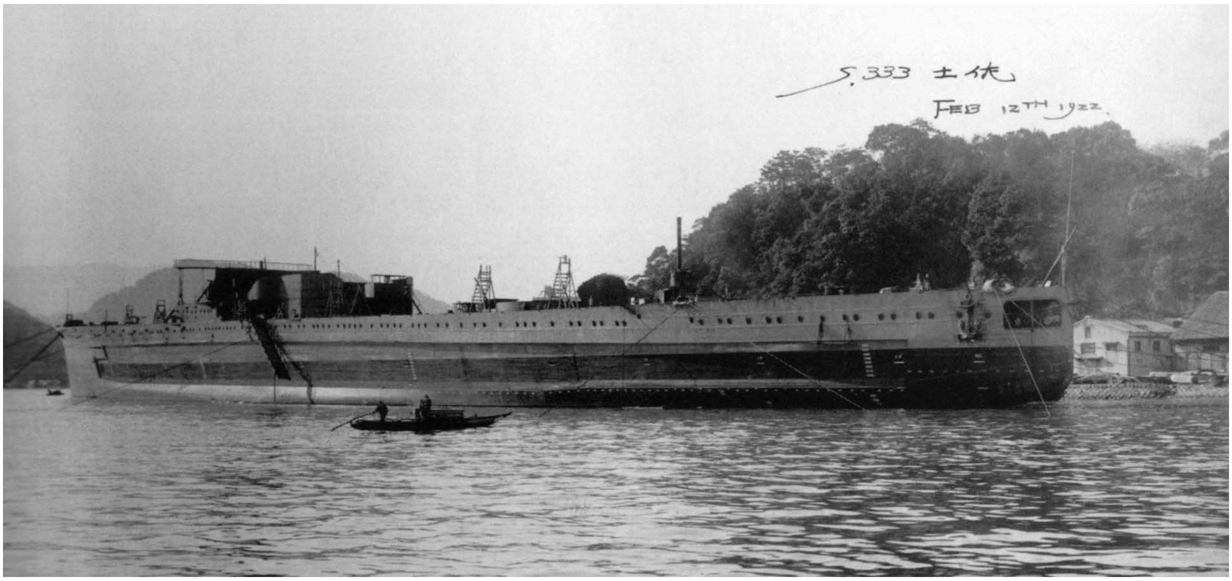
VC = Vickers cemented armour
VNC = Vickers non-cemented armour
NVNC = New Vickers non-cemented armour
HTS = High Tensile Steel

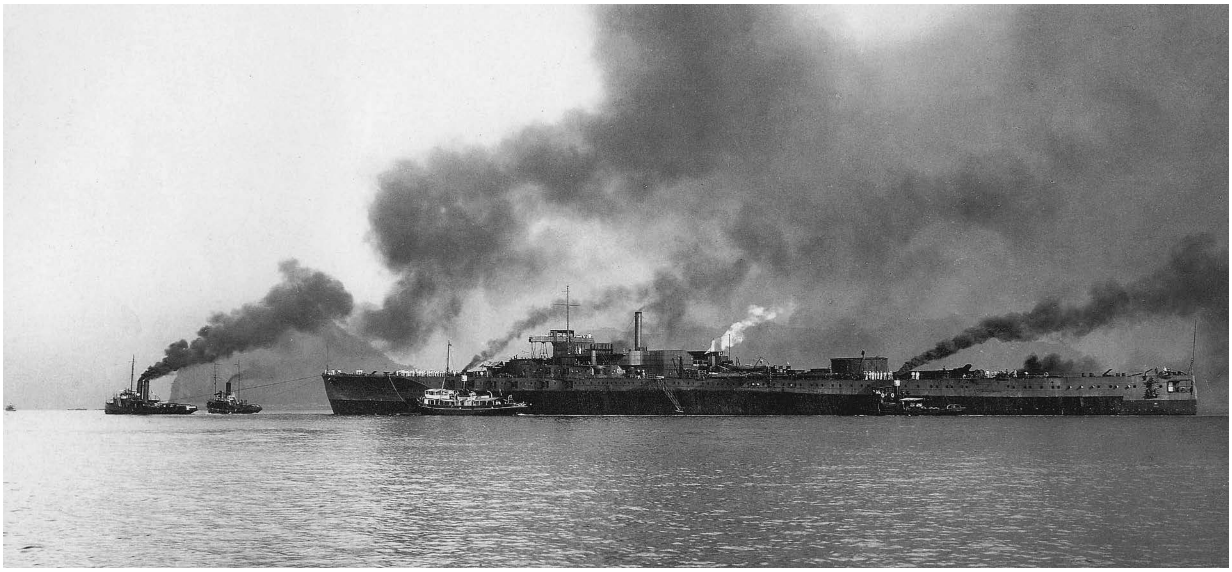
Between the lower edge of the inclined hull side armour and the double bottom there was a prominent bulge. The shape of the latter was improved compared to that of the *Nagato* class both with regard to torpedo defence and a more controlled roll. Within the bulge and roughly parallel with the outer wall, an inclined longitudinal torpedo bulkhead was fitted with a stand-off of 10 feet (3.05m) to provide for the expansion of the gases generated by a torpedo or mine detonation. The bulkhead comprised three layers of 1in plates of high tensile steel (HTS) for a total thickness of 3in (76mm). In contrast to the curved shape of the torpedo bulkhead in *Nagato*, which had been difficult to manufacture, it was 'V'-shaped with the lower edge seated on the ship's bottom, the point of the 'V' being connected to the lower part of the armour belt by plating which was inclined slightly upwards (see plan). The upper part of the bulkhead provided splinter protection behind the belt. Between the lower deck and the middle deck, from the top of the 'V', there was a thinner vertical splinter bulkhead with a thickness which varied between 1.25in and 0.5in (32–12.7mm). Inboard of the torpedo bulkhead there was a vertical longitudinal bulkhead of 0.75–0.5in steel (19–12.7mm: lower/upper) to enclose the machinery spaces. The height of the double bottom beneath the boiler rooms (except No 4 BR) was increased, and subdivision for the stowage of reserve feed water improved.

For the first time in an IJN warship there was direct protection for the boiler uptakes. The *Nagato* class had 21 boilers, but rapid progress in boiler technology meant that the *Kaga* class was fitted with only 12 of the more powerful Kampon Ro Gō type. The deck area occupied by the smoke passages was therefore much reduced compared to the generated power, and the uptakes could be combined in a single funnel. The protection of this single smoke passage became more important and the reduction in area made possible alternative methods of protection. The direct protection method had already been adopted by the US Navy before the outbreak of the First World War, but the RN and IJN had continued to use armoured coamings around the openings in the protective deck due to the weight cost involved in direct protection. However, the plunging shell associated with ever-increasing ranges of engagement meant that armoured coamings were no longer effective. The boiler uptakes were now protected by VC armour 9in (229mm) thick between the middle deck and the shelter deck, and the openings in the lower deck had armoured gratings to keep out splinters.

With regard to horizontal protection, the middle deck became the main armoured deck. It comprised 2.5in (64mm) NVNC plates secured to 1.5in (38mm) HTS, for a total thickness of 4in (102mm); this was an increase from the 2.75in (70mm) middle deck of the *Nagatos*. The lower deck beneath comprised two layers of 0.75in (19mm) HTS to provide splinter protection over the machinery and magazines.

When these ships were designed the anticipated engagement range was thought to be between 15,000m and 20,000m. The thicknesses of the vertical and hori-





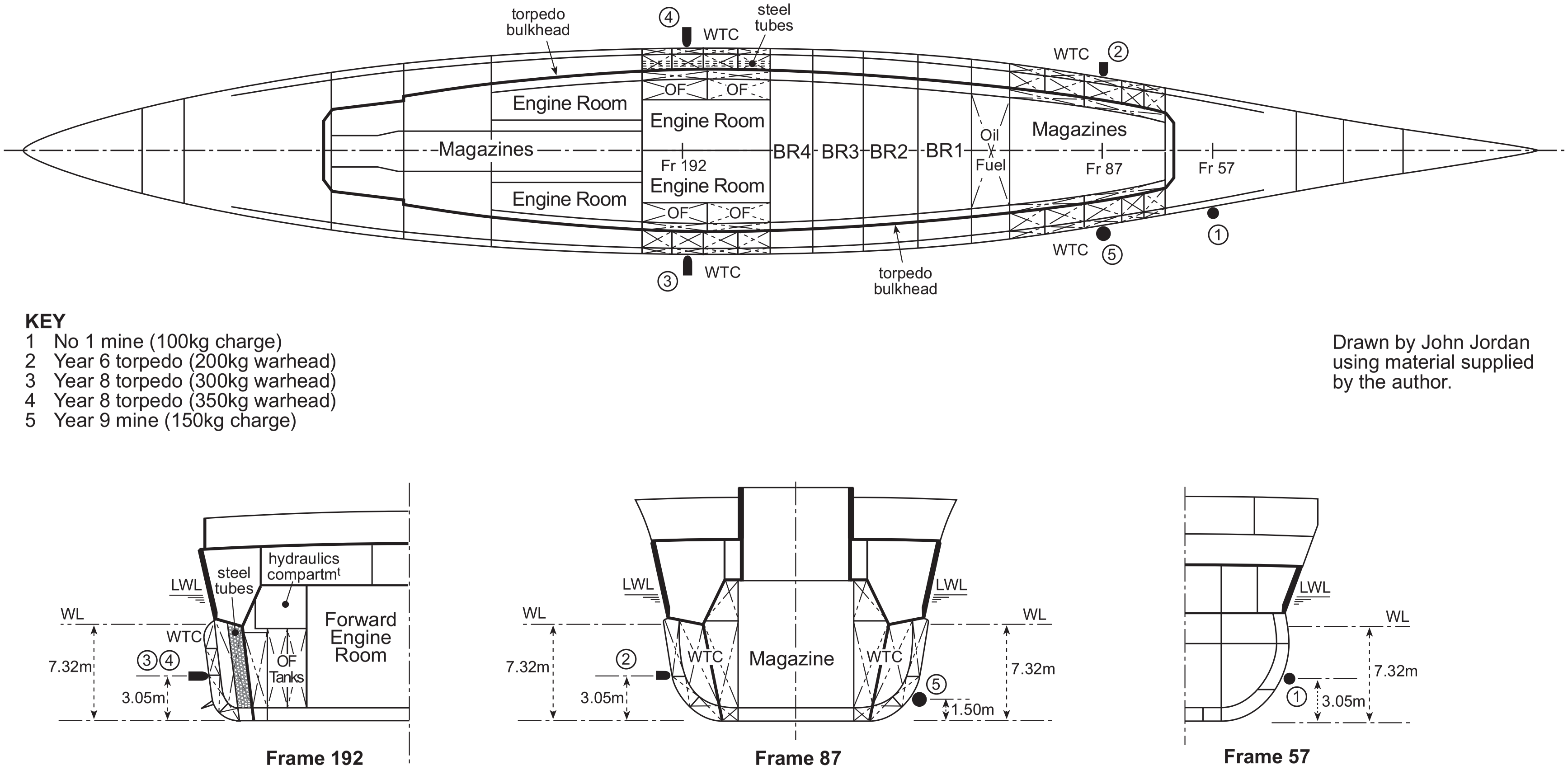
Left: A photo of the launch of the battleship *Tosa* at the Nagasaki Shipyard of Mitsubishi on 18 December 1921. Two months later, on 5 February 1922, the capital ships of the Eight-Eight Fleet were cancelled on the conclusion of the Washington Treaty. **Above:** The upper photo was taken on 12 February 1922 when *Tosa* was awaiting a final decision on her disposal. The lower photo was taken on 1 August 1922 when *Tosa* was towed to Kure; note the tugs forward and along her sides. (*Hachi Hachi Kantai no Shuryokukan*)

zontal armour were insufficient to stop 16in (40.6cm) AP shell fired from such long range. However, it was reasoned that the kinetic energy of the enemy AP shell would be nullified by the armour, the shell would break up and the time-delay fuse would operate prior to penetration so that only a small part of the detonation gases would enter the ship. These noxious gases, together with splinters from the shell and the side plating, would be kept out of the ship's vitals by the inboard splinter bulkheads. Protection of this central citadel would preserve buoyancy so that even if the unprotected fore and after ends were riddled the ship would not sink. Conceptually, this represented a major advance on the *Nagato* class, and trials with the uncompleted hull of *Tosa* would inform the design of the super-battleships of the *Yamato* class.

The *Tosa* Trials

Numerous trials were carried out to test the protection system, of which the six conducted in Hiroshima Bay from 6 to 14 June 1924 to test the underwater protection system constituted the main part. It was anticipated that these would confirm the effectiveness of the underwater hull arrangements adopted for the *Nagato* class. The results would be used in combination with further experiments using one-third scaled models to work out an equation in 1928 which would underpin the design of the

Tosa Trials


torpedo bulkhead
④
WTC
steel tubes
WTC
②
OF
OF
Engine Room
Engine Room
Magazines
Fr 192
Engine Room
Engine Room
OF
OF
BR4
BR3
BR2
BR1
Oil
Fuel
Magazines
Fr 87
Fr 57
①
WTC
⑤
③
WTC
torpedo bulkhead
LWL
steel tubes
hydraulics compartmt
WL
WTC
Forward Engine Room
7.32m
③④
OF Tanks
3.05m
Frame 192
LWL
LWL
WL
WL
7.32m
②
WTC
Magazine
WTC
7.32m
3.05m
⑤
1.50m
Frame 87
LWL
WL
7.32m
①
3.05m
Frame 57

KEY
1 No 1 mine (100kg charge)
2 Year 6 torpedo (200kg warhead)
3 Year 8 torpedo (300kg warhead)
4 Year 8 torpedo (350kg warhead)
5 Year 9 mine (150kg charge)

Drawn by John Jordan
using material supplied
by the author.

Schematic showing the trials of the underwater protection scheme of *Tosa*. Mines or torpedo warheads with explosive charges of varying strength were detonated outboard of the forward magazines and the engine rooms.

Table 6: Results of Firing Trials

Type of shell	Corresponding firing range	Angle of fall	Striking velocity	Remarks
14in (36cm) common	16,000m	35°	443m/s	Plate dished
14in (36cm) new type	16,000m	35°	443m/s	Deep dish
16in (40cm) common	20,000m	35°	439m/s	Traces of pressure
16in (40cm) new type	20,000m	35°	439m/s	Penetrated, then broke up

underwater protection systems of Japanese warships to the end of the Pacific War.[13]

Generally speaking, the factors to be considered in utilising this structure were:

- the weight of explosive
- the distance between the point of detonation and the torpedo bulkhead
- the composition and thickness of the torpedo bulkhead. (The problem was to find out the balance between them. It was solved theoretically by the equation, and graphs worked out on its basis to show the expected balance.)

Proving Ground Trials

Preparatory firing trials were carried out at Kamegakubi Proving Ground outside Kure port against 11in (279mm) thick armour plates produced for *Tosa*'s sister *Kaga* using 14in (36cm) and 16in (40cm) common and new-type AP shells. The results are summarised in Table 6.

The twin purposes of the trials were to test the properties of different types and calibre of shell and to test the resistance of the belt armour, and valuable data were obtained. The table makes it clear the thickness of the armour was insufficient against the new-type 40cm AP shell fired at 20,000m range,[14] but the new-type 14in AP shell was unable to penetrate even at shorter ranges. The difference in effect between the common type and the new AP shell can be considered normal.

Real Firing Trials

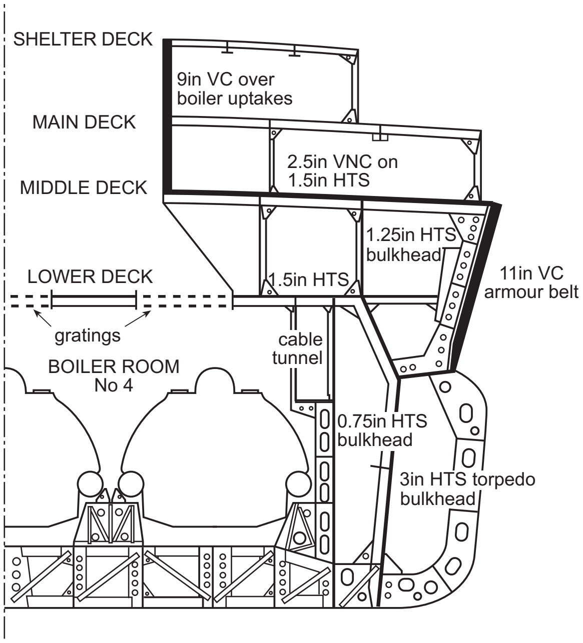
Firing Trials with 16in AP Shells

The 16in AP shells were given a trajectory, striking angle and velocity corresponding to a firing distance of 20,000m, as in the preparatory trials. *Tosa* was moored in the Inland Sea in front of the Kamagakubi Proving Ground and was struck at particular points.

Near-Miss 10m From Side of Hull

The shell hit to port 2.44m forward of the axis of the 4th main gun barbette and about 0.6m below the lower edge of the belt armour (2.25m beneath the waterline). The detonation tore a moderate hole 1.83m (L) by 1.22m (W) in the shell plating, a smaller hole 1.03m x 0.87m in the inner skin, but a larger hole 12.5m x 5.18m in the 3in longitudinal torpedo bulkhead with an inclination of 6 degrees to the horizontal. After passing through a further five longitudinal bulkheads and causing holes of 2.44m x 1.22m, 2.34m x 2.4m, 2.49m x 1.83m, 0.91m x 1.27m, and 0.91 x 0.87m respectively, the remains of the shell came to a halt close to the middle line of the hull. The list increased from 4°15' to 9°20' as a result of the ingress of 2,300 tons of sea water.

***Tosa:* Protection**



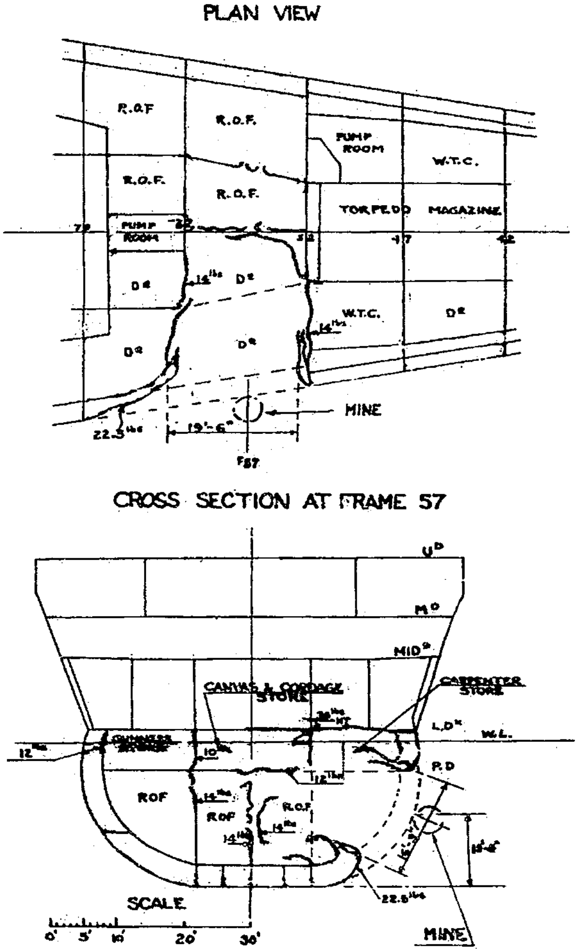
Midship half-section of the battleship *Tosa,* showing the distribution of armour and protective plating over the citadel and the underwater protection system; the latter was influenced by contemporary British thinking as exemplified by the battlecruiser *Hood*. (Drawn by John Jordan using material supplied by the author)

Near-Miss 25m From Side of Hull

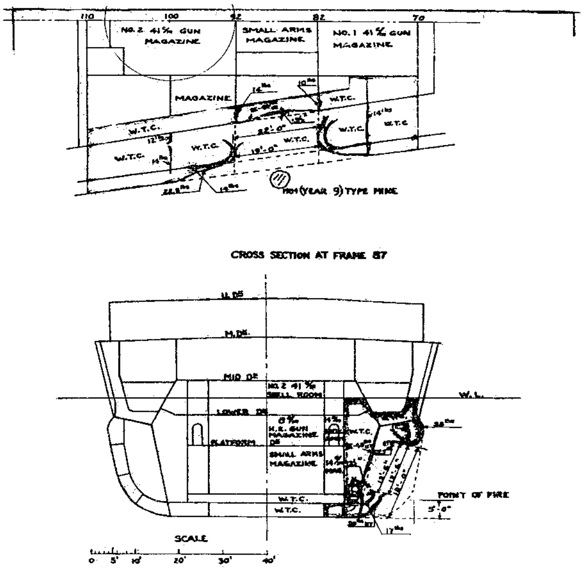
The shell hit the surface with an angle of fall of 17 degrees at a distance of 25m from the hull and continued its trajectory, which gradually became flatter underwater. It pierced the bulge to port forward of the 4th main gun barbette (*ie* 13.87m away from the hit described above) at Frame 228, 1.79 metres below the lower edge of the belt armour (3.56m below the waterline), and caused a hole of 4.27m x 2.44m in the bulge. It went on to pierce the longitudinal torpedo bulkhead and the splinter bulkhead over the machinery spaces and detonated inside the after engine room. The hole in the torpedo bulkhead was relatively small, only 1.43m x 0.43m, but that in the splinter bulkhead measured 6.25m x 1.98m and there was also a hole 3.3m x 2.76m in the double bottom. The walls of the after engine room and the adjacent compartments had numerous splinter holes, particularly in the upper half. The list increased from 4°35' to 10°06' as a result of the ingress of 3,000 tonnes of sea water.

Hit On Belt Armour (failed to penetrate)

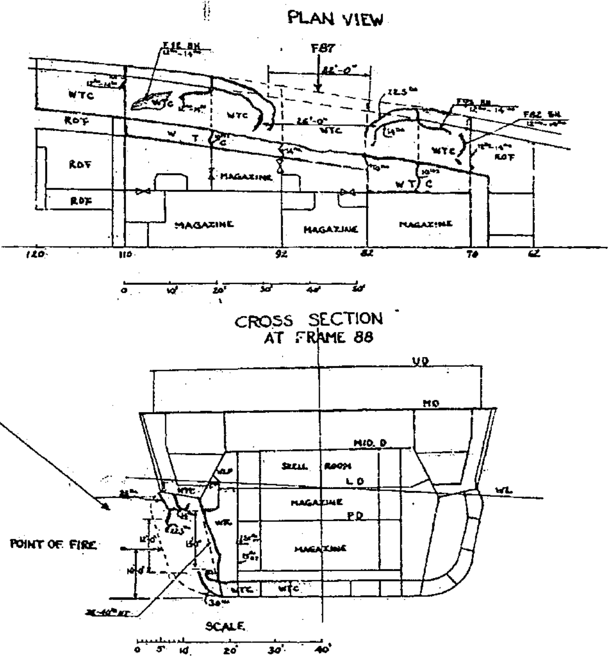
The shell struck 1.06m below the upper edge of the belt armour at Frame 240 (after engine room) with an angle of fall of 39 degrees and a remaining velocity of 435.8m/sec. There were pressure cracks and melting on the surface of the armour plate and the shell was broken up.

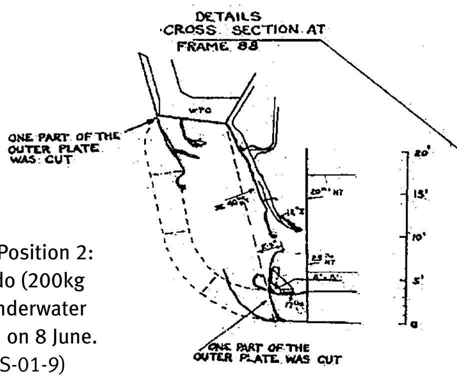

PLAN VIEW
R.O.F
R.O.F.
R.O.F.
R.O.F.
PUMP ROOM
W.T.C.
TORPEDO
MAGAZINE
PUMP ROOM
D^R
D^R
D^R
D^R
W.T.C.
D^R
MINE
22.5^{lbs}
19'-6"
F57
CROSS SECTION AT FRAME 57
U^D
M^D
MID^D
CANVAS & CORDAGE STORE
CARPENTER STORE
L.D^K
W.L.
12^{lbs}
10^{lbs}
ROF
ROF
R.O.F
P.D
22.5^{lbs}
SCALE
0' 5' 10' 20' 30'
MINE

Results of Test at Position 1: No 1 mine (100kg charge) against underwater protection system on 8 June. (USNTMtJ, Report S-01-9)


110
100
92
82
70
NO. 2 41% GUN MAGAZINE
SMALL ARMS MAGAZINE
NO. 1 41% GUN MAGAZINE
MAGAZINE
W.T.C.
W.T.C.
W.T.C.
W.T.C.
W.T.C.
W.T.C.
22'-0"
19'-0"
22.5^{lbs}
14^{lbs}
No1 (YEAR 9) TYPE MINE
CROSS SECTION AT FRAME 87
U. DK
M. DK
MID DK
NO. 2 41% SHELL ROOM
LOWER DK
H.E. GUN MAGAZINE
PLATFORM
SMALL ARMS MAGAZINE
W.T.C.
W.T.C.
W.L.
POINT OF FIRE
5'-0"
17^{lbs}
SCALE
0 5' 10' 20' 30' 40'

Results of Test at Position 5: Year 9 type mine (150kg charge) against underwater protection system on 13 June. (USNTMtJ, Report S-01-9)


PLAN VIEW
F87
22'-0"
WTC
WTC
WTC
W T C
WTC
ROF
ROF
ROF
ROF
MAGAZINE
MAGAZINE
MAGAZINE
MAGAZINE
120
110
92
82
70
62
0 10' 20' 30' 40' 50'
CROSS SECTION AT FRAME 88
UD
MD
MID. D
SHELL ROOM
L D
MAGAZINE
PD
MAGAZINE
WTC
WTC
WTC
WL
POINT OF FIRE
SCALE
0 5' 10' 20' 30' 40'


DETAILS CROSS SECTION AT FRAME 88
WTC
ONE PART OF THE OUTER PLATE WAS CUT
20'
15'
10'
5'
0
ONE PART OF THE OUTER PLATE WAS CUT

Results of Test at Position 2: Year 6 type torpedo (200kg charge) against underwater protection system on 8 June. (USNTMtJ, Report S-01-9)

Hit On Belt Armour (penetrated)

The shell struck the main armour belt at the junction of two plates between Frames 270 and 272, a little below the centre of the plate with an angle of fall of 41 degrees and a remaining velocity of 440m/sec. The shell pierced the plate, making a hole 0.41m x 0.83m, but did not detonate and fell away. Penetration of the armour at such a steep angle was considered unusual.

Evaluation of Firing Trials

Among these experiments the 25m near-miss is described in several Japanese books dealing with interwar naval construction, and its effect was primarily responsible for the development of the 'underwater trajectory shell' (Type 91 AP shell for calibres ranging from 15.5cm to 46cm)[15] and improvements in underwater protection.

The underwater shell trajectory phenomenon was well known. The IJN had discovered these effects at the time of the repair of the captured Russian battleships sunk in Port Arthur during the Russo-Japanese War. However, the results of the accidental near-misses during the trials, particularly in the case of the second shell, were more significant than expected, and the Type 91 AP shell assumed the status of a secret weapon in the Pacific War, not only with regard to materials, fabrication, and general design but also due to the compressed nature of the development programme. Protection against this 'underwater trajectory shell' was also considered when the pre-Washington Treaty capital ships were rebuilt, and incorporated into the design of the cruisers of the *Mogami* and *Tone* classes and the battleships of the *Yamato* class. The ships with the most advanced protection schemes to counter underwater shell were the reconstructed battleships of the *Nagato* class (hull side over the magazines) and the *Yamato*s.

In addition to this revelation of the effectiveness of shells with an underwater trajectory, valuable data were obtained with regard to armour systems and hull structure, armour thickness and securing techniques, and splinter protection.

Underwater Protection versus Mines

No 1 Mine B (explosive charge 100 kg)

This mine was detonated to starboard at Frame 57, 3.66m below the waterline. The hole in the shell plating and inner skin was 5.95m x 5.03m (area 22m^2) and plating was deformed over an area of 61m^2. There was an ingress of 995 tons of sea water: 22 compartments were flooded of which 17 were flooded immediately. The flooded area was 12m either side of the centre of detonation. The list shifted from 0°14' to port to 1°40' to starboard.

It was concluded that the explosive force of this mine would not have been able to inflict fatal damage on a battleship of the *Tosa* class. However, the change of trim at the bow was nearly 3ft (0.9m), and for 54 minutes a list of 1 degree was produced, so a ship which had suffered this damage would have had trouble maintaining fleet speed. There was doubt as to whether the forward torpedo magazine would explode when the mine detonated (see further test below). It was also unclear whether the fuel oil in the outer tanks would ignite when the mine was detonated; further studies were considered necessary.

Year 9 Type Mine (explosive charge 150 kg)

The charge was detonated to starboard at Frame 87 (opposite the detonation point of the Year 6 Type torpedo), 6.34m below the waterline. The dimensions of the hole in the bulge and double bottom were 5.79m x 5.18m (area 17.7m^2), and the area of deformed plating amounted to 121m^2. The longitudinal torpedo bulkhead withstood the pressure but was deformed over an area of 30m^2 and there were also melting traces around the line of the centre of concussion. The largest deformation was less than 0.5m. The ingress of sea water amounted to 726 tons and was distributed over 20 compartments, of which ten were flooded immediately after the detonation. The length of the immersed part was 23m with an average depth of water of 4m. The list shifted from 3°50' to port to 0°48' to starboard.

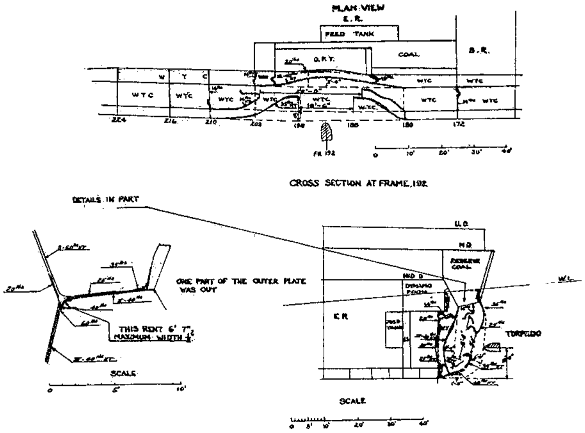
The investigation committee concluded that, although the destructive force was commensurate with the weight of the charge, it was difficult to damage the underwater protection system of a battleship of the *Tosa* class, and the weight of the explosive charge would need to be increased in order to achieve this.

Underwater Protection versus Torpedo

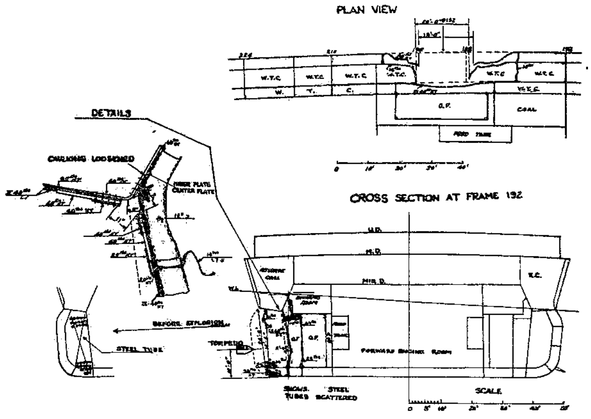
A total of three underwater detonation tests using torpedo warheads were carried out to study the effect on the underwater protection system. Investigations were also made into the effect of the collapsing water column caused by the underwater detonation upon the provisional superstructure, and the impact of sea water immersion on voice pipes and electrical systems. One Year 6 Type torpedo (explosive charge 200kg) was used against the forward protected area at Frame 87 abreast the forward magazines, and two Year 8 Type torpedoes (explosive charges 300kg and 350kg respectively) were detonated on both sides of the hull at Frame 192 abreast the after engine room. In order to be certain of the location of the centre of concussion, warheads with the required explosive charge were detonated at the decided position rather than using live torpedoes.

Year 6 Type Torpedo (explosive charge: 200 kg)

The explosive charge was detonated to port at Frame 87, 4.06m below the waterline. The hole in the shell plating (bulge) measured 6.7m x 3.66m (the area was 22.3m^2 because of the irregularity) and the area deformed by the gas pressure amounted to 130m^2. The longitudinal torpedo bulkhead was holed 1.22m x 0.3m and was deformed over an area of 84m^2. There was an ingress of 1,008 tons of sea water: 19 compartments flooded immediately and a further nine slowly over a length of 38m


PLAN VIEW
CROSS SECTION AT FRAME 192
DETAILS IN PART
ONE PART OF THE OUTER PLATE WAS CUT
THIS RENT 6' 7" MAXIMUM WIDTH
TORPEDO
SCALE

Results of Test at Position 3: Year 8 No 1 type torpedo warhead (300kg charge) against underwater protection system on 9 June. (USNTMtJ, Report S-01-9)



Results of Test at Position 4: Year 8 No 2 type torpedo (350kg charge) against underwater protection system on 12 June. (USNTMtJ, Report S-01-9)

(Frames 70–110) with an average depth of 5m. The list changed from 1°40 to starboard to 4°36’ to port.

There was a 6-degree port and starboard heel at the time of the detonation. It was concluded that this type of damage would have administered a major shock to the control of the ship and the use of its weapons, and it was greater than had been anticipated following model testing. However, it was considered that the explosive force of this type of torpedo was incapable of inflicting vital damage on a battleship of the *Tosa* class.

Year 8 Type No 1 Torpedo (explosive charge 300 kg)

The explosive charge was detonated to starboard at Frame 192, 4.07m beneath the waterline, and created a hole 5.61m x 2.44m (area 14.8m^2) in the bulge and one of 8.53m x 6.1m in the double bottom. The area of deformed plating amounted to 158m^2. The longitudinal torpedo bulkhead was deformed over an area of 93m^2, and the seams of the outermost of the three protective plates were torn in several places around the centre of concussion. There was an ingress of 1,203 tons of sea water: 26 compartments flooded immediately after the detonation and another followed slowly. The flooded area had a length of 27m and the average depth water was 4m. The list changed from 2°51’ to port to 5°22’ to starboard.

In this test it was concluded that there was equality between the explosive force of this type of torpedo against a battleship of the *Tosa* class and the ship’s underwater protection system. However, in this test the ship’s draught was 23ft 3in, which was about 10ft less than the ideal combat draught. Moreover, the depth of the point of explosion was 13ft 3.25in, which was somewhat shallower than the normal depth setting used with torpedoes; the explosive force was thereby reduced.[16] Nevertheless,

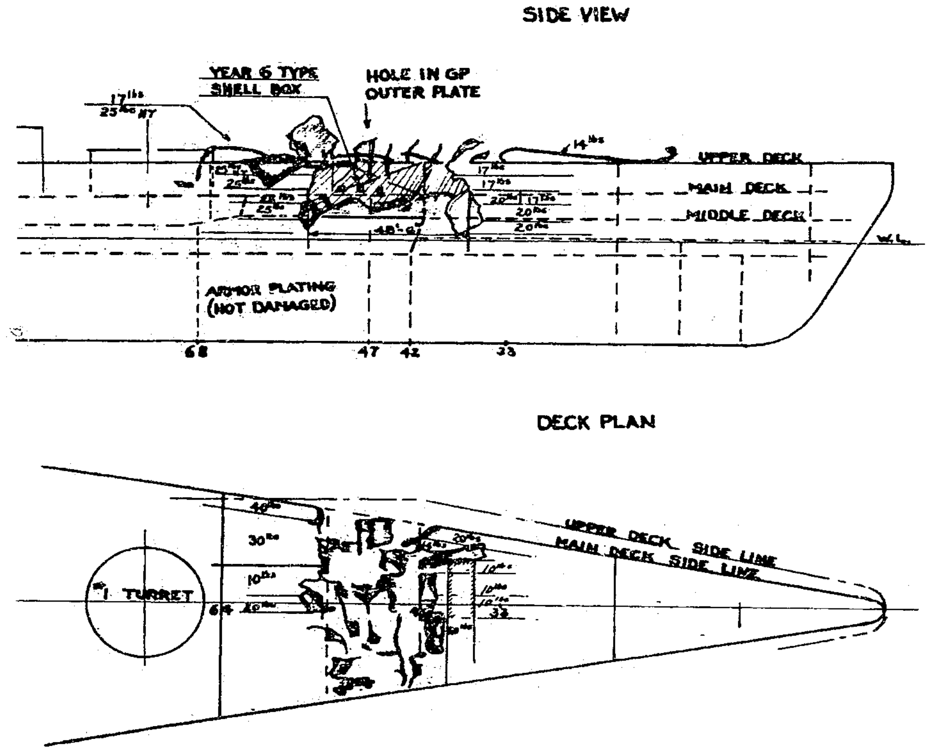
Table 7: **Trials of the Underwater Protection System**

	Charge		**Area damaged (m^2)**					
Date	**Size**	**Location**	**Depth below wl**	**Size of hole**	**Plating**	**Torpedo b/head**	**Deflection of deck**	**Water ingress**
6 Jun (1)	100kg	Std F57	3.66m	22.00	69.75	–	–	995t
8 Jun (2)	200kg	Port F87	4.06m	22.32	130.2	83.7	0.62m	1,008t
9 Jun (3)	300kg	Std F192	4.12m	14.86	157.9	92.9	1.02m	1,203t
12 Jun (4)	350kg	Port F192	4.88m	26.01	111.5	92.9	0.71m	1,160t
13 Jun (5)	150kg	Std F87	6.34m	17.67	120.9	29.8	0.31m	726t
14 Jun (6)	337kg	Port F265	5.43m	?	?	?	3.6m	1,650t

Notes:

With reference to the damage to the torpedo bulkhead the following explanations are given in the order of the tests:

1. The torpedo bulkhead was undamaged.
2. In the vicinity of the centre of detonation a hole 1.32m x 30.3cm was made.
3. In several places, in the vicinity of the centre line of impact, the seams of the outermost of the three protective plate were torn.
4. Since steel tubes were embarked there was only partial damage; nevertheless, along the curved upper seam there was a tear 10.97m in length.
5. In places, around the centre line of impact there were melting traces on the face of the bulkhead.
6. The centre of detonation was at the curved part of the protective plating so that sharp-edged steel pieces were cut out. The torpedo bulkhead was destroyed and depressed inside about 3.6m.



Results of Test in Torpedo Room: Explosion of warheads fitted on current torpedoes in the torpedo room on 16 June. (USNTMtJ, Report S-01-9)

it was thought that an increase in the explosive charge would have been necessary to completely defeat the underwater protection system.

Year 8 Type No 2 Torpedo (explosive charge 350 kg)

This charge was detonated directly opposite the position of the previous test but a little deeper (4.88m beneath the waterline). It was anticipated that a 350kg explosive charge would overwhelm the underwater protection system, so four columns of steel tubes 9in (229mm) in diameter and 0.25in (6mm) thick were placed in front of the protective bulkhead in order to limit damage and maintain buoyancy.

Compartments flooded				List	
Immediate	Slow	Total	Before	After	Difference
17	5	22	0°14’	1°40’	1°54’
19	9	28	1°40’	4°36’	6°16’
26	1	27	2°51’	5°22’	8°13’
15	11	26	1°0’	5°20’	6°20’
10	10	20	3°50’	0°48’	4°38’
?	?	?	?	?	4°32’

The hole in the bulge and double bottom measured 6.1m x 5.49m (area 26m^2) and the area of deformed plating amounted to 111m^2 in the double bottom and 93m^2 in the longitudinal torpedo bulkhead. In the latter a rent of nearly 11m length was made along the curved upper seam, but no other damage were observed. There was an ingress of 1,160 tons of sea water: 26 compartments were flooded of which 15 filled immediately, the others slowly. The flooded area had a length of 26m and the average depth water was 4m. The list changed from 1°00’ to starboard to 5°20’ to port.

Although the condition of the flooded compartments suggested that the anticipated explosive force was produced, it was concluded that it could not produce adequate results against underwater defences using steel tubes. However, they could not stop flooding behind the torpedo bulkhead and this meant that the heavy oil tanks behind it would have been contaminated with sea water. Although the steel tubes were deemed to be effective, their weight was 150 *kin* (1 *kin* = 1.3lb) for each square foot of bulkhead, which meant that the tubes were heavier than the longitudinal bulkheads themselves; it was concluded that if this much weight were used elsewhere, a better means of underwater protection could be devised, and further studies were recommended.

Other Trials

Underwater Protection versus Bomb

A medium-sized bomb filled with 337kg of *Shimose* explosive was detonated at Frame 262, 3.05m above the hull bottom and 1.52m from the hull side. The torpedo bulkhead was breached and the ingress of water was 1,650 tons, more than in any other test. The hole in the hull plating was also the largest; however, the damage was of a secondary nature compared to the cracking of the longitudinal torpedo bulkhead. The increase in the weight of the *Shimose* charge compared to test 5 (150kg mine) was sufficient to cause the expected destruction of the underwater protection system.

Explosion of Warheads of Year 6 Type Torpedo in the Torpedo Room

The purpose of this experiment was to find out the damage that might be expected in the event of the detonation of torpedo warheads in the torpedo tubes as a result of enemy gunfire or bombing. Three Year 6 Type torpedo warheads, each charged with 200kg of explosive, were utilised, of which two were placed at distances of 4.57m and 1.37m respectively from that in the centre to port at Frame 47 in the torpedo room. The warheads were placed on a pedestal mounted on the middle deck so that they pointed outwards and were in contact with the shell plating above that deck. The warhead in the centre was then detonated and the following damage observed:

- All the lateral bulkheads above the middle deck between Frames 33 and 62 were breached, many joints were separated and the bulkheads were riddled with splinter holes.
- The middle deck was completely separated at Frame 41 and was holed between Frames 40 and 52 with all the butts cut through, and transverse and longitudinal cracks throughout.
- The lower deck aft of Frame 41, which had the 4in (102mm) thick armoured bulkhead, was undamaged.
- On the upper deck all the plating between Frames 35 and 56 was blown away and the largest hole had a length of 20.87m. All the beams were severed.
- The starboard shell plating between the lower deck and the upper deck was blown away over a length of 14.78m, and within this area the frames were completely destroyed.
- The damage to port was identical, but the length of the area within which everything was destroyed amounted to 18.9m. In the report on the trials the damage was called ‘catastrophic’.

The following modifications were proposed:

- In order to reduce the damage from torpedo explosions and protect from fragments from enemy bombs, the torpedo casemates should be armoured.
- When this cannot be done it is necessary to use a comparatively strong steel plate on both sides of the torpedo tubes, and by making one side weaker to channel the destructive force in that direction.
- The torpedoes mentioned in the two preceding items have thin warheads pointing outboard, and it is necessary to equip the sides of the ship around the tubes with strong steel plating. Moreover, the torpedoes ready to be fired should be protected with steel plates of similar thickness, and the other torpedoes should be stowed in an armoured compartment.

Despite these conclusions, no battleship was subsequently armed with torpedoes, and the recommendations were not applied to the protection of the torpedo rooms of the heavy cruisers.

Underwater and Deck Protection versus Bombs

Underwater Protection versus Near-Miss

This was the detonation of 337kg of *Shimose* explosive near No 5 main gun barbette and 1.52m up from the double bottom to starboard. Between Frames 252 and 274 a hole 13.41m x 8.84m was opened up at Frame 265. Ten compartments were flooded with 1,650 tons of sea water over a length of about 24m, and the depth of water inside the hull was 6m. The detonation pressure at the centre of concussion was above 32 bar, and at 4.57m and 6.1m above 16 bar and 5 bar respectively.

The following conclusions were drawn:

- The underwater detonation power of the bomb was greater than expected
- Structural weaknesses included the non-continuous joints of the torpedo bulkhead, too small a stand-off between the shell plating and the joints of the protective plates, and outer compartments with too small a volume to absorb the gas pressure.

Unprotected Deck versus Large Bomb with Impact Fuse

An explosive charge of 549kg was placed vertically on the upper deck at the middle line of the hull at Frame 314 and detonated. The hail of splinters lasted for about 10 seconds. The upper deck was broken and deformed. A hole measuring 9.14m x 4.57m appeared and between Frames 304 and 326 the deck was deformed over a length of 19.8m and a width of 16.76m, the maximum depth of the deformation being 3.05m. A part of the explosive gases penetrated to the middle deck and cut away the lower edges of the longitudinal and several lateral bulkheads in the area mentioned above. The middle deck, which was the protective deck with 4in thick armour, was pierced in the line of the centre of concussion (the diameter of the hole was 0.63m) and a wide area around that point showed numerous traces of splinters which would undoubtedly have caused numerous casualties. However, since most of the destruction was above the waterline, the bomb would not have inflicted any vital damage on the ship.

Protective Deck versus Large Bomb with Delay Fuse

An explosive charge of 1,086kg was placed on the middle deck in the main passageway to port at Frame 282 and detonated. As before, a hail of splinters flew to a range of

800–900m, the maximum distance being 1,500m. The detonation tore a hole 1m x 1.2m in the upper deck around the line of the centre of concussion and another of 1.52m x 2.13m in the armoured middle deck. The lower deck also had a hole of 0.91m in diameter. In addition the gas penetrated to the hold and the double bottom was also damaged. The outer plating and inner skin were blown away above the middle deck between the 5th main gun barbette and Frame 306 to starboard and from Frame 226 to Frame 306 to port.

Due to the lack of data – *eg* the range of damage below the middle deck, amount of flooding, and damage to the 5th or 4th main gun barbettes – no reliable conclusions could be made, but it was considered that even this unrealistically large amount of explosive would not have resulted in vital damage to the ship, which should have retained most of its fighting power. However, the area of destruction above the middle deck was significant and there would have been considerable losses among the crew.

Endnotes:

[1] Conflict between the Army (IJA) and the Navy (IJN) before and during the Russo-Japanese War of 1904–05 led to the submission of a draft of a national defence policy by Lt-Cdr Tanaka Gi'ichi to Army Minister Yamagata Aritomo, who made some revisions and submitted it to the emperor. After the draft had been considered and approved by the advisory councils, the emperor signed it, although there are indications that he continued to have reservations. The aim of the policy was to harmonise and control the force strengths and budgets of the two armed services. However, the IJA and IJN disagreed as to the major threat posed to Japan by potential enemies, and the political struggle between the two was exacerbated. There were separate supreme guidance and staff bodies, and national defence policy was confused up to the end of the Pacific War.

[2] The eight-year limit was valid only for battleships and armoured/battle cruisers, and not for the other ship types. The battleships were to make up the main force (*shuryoku butai*) of the Combined Fleet, and the high-speed armoured/battle cruisers the mobile force (*yūgeki butai*). This organisation was essentially the same as that employed during the Sino-Japanese and Russo-Japanese Wars and was deemed to be partially responsible for the Navy's success. The principle seemed to be confirmed by the Battle of Jutland in May 1916, where the battle cruisers operated as a fast vanguard for the main body of the respective fleets.

[3] Due to her entry into the First World War in 1917 the USA would be forced to concentrate upon urgently-needed ASW vessels at first, but in the summer of 1918 the 1916 programme was revived in virtually unchanged form.

[4] In the Overall Instructions of the Japanese Government to its representatives, paragraph 4 stated: '… the representatives may discuss even *faits accomplis* or questions concerning specific countries … but should take timely steps to avoid a situation in which Japan's past actions and policies alone are likely to be criticised.' – a clear reference to the Twenty-One Demands to China in 1915.

[5] Enomoto Shigeharu, 'Reminiscences on the Washington Conference in 1921', Foreign Ministry, Lecture in the Archive of the Diplomacy Documents, 22 March 1974.

[6] Yamanashi Katsunoshin Publication (*Shuppan*) Board (*Iinkai*), Estate of Teacher Yamanashi Katsunoshin (*Yamanashi Katsunoshin sensei ihōroku*), Suikōkai, not for sale, 1968, 66–67. Quoted in *Sensho sōsho*, Vol 91, 182.

[7] *Ibid.* A longer quotation can be found in Asada Sadao, *From Mahan to Pearl Harbor*, 57.

[8] *Ibid.* After returning, the head of the NTD ordered a reduction in shipbuilding costs, whereupon Captain Hiraga Yuzuru, then head of the Preliminary Design Section, responded with a 'light structure' proposal (Naito/Makino, *Life of Hiraga Yuzuru*, 80).

[9] Berthing and docking facilities at the civilian shipyards are described in a three-volume work published by the Shipbuilders Association (*Zōsen kyōkai*), *A History of Modern Shipbuilding in Japan* (*Nihon Kindai Zōsen-shi*), Volume 1 covers the Meiji era, Volume 2 the Taishō era, and Volume 3 the Shōwa era (*jidai*), but data on the naval dockyards and other public facilities are sparse except in the third volume of this trilogy.

[10] The incomplete battleship *Kaga* and battle cruiser *Akagi* were rebuilt as aircraft carriers.

[11] This is the date given In Naito Hatsuho's *Life of Hiraga Yuzuru*, 581, but Hiraga in his *On the Post-War Development of the Ships of the Imperial Navy* states: 'About that time (July, 1916) the report of the Jutland Engagement was received, and following a careful study of the lessons of that great sea battle the design was revised, increasing displacement, speed and defensive power, and this new design was completed in September of the same year'. In his lecture in the presence of the Crown Prince, Hiraga explained that the improved design 'was adopted in September'. It appears likely that Hiraga completed the changes in August, the Higher Technical Conference adopted them in September, and the Navy Minister ordered their implementation in October.

[12] Replaced by Yamada Sukehira on 1 December 1917.

[13] The underwater protection systems, including the equation, are dealt with in *Kaigun suirai-shi*, 447–48 and in Fukuda's *Gunkan kihon keikaku shiryō*, 103, which also gives a brief summary of the *Tosa* trials. Fukuda Keiji deals with protection (94–108) and provides data about tests which cannot be found in any other Japanese book the author was able to use. A fold-out diagram (103-2) shows the results of numerous small-scale experiments and is quite interesting. A slightly modified equation is published in Report S-01-2 Surface Warship Hull Design of the USNTMtJ, 41.

[14] The immune zone was designed to be from 15,000m to 20,000m; 16in AP shell should not have penetrated the armour within these ranges.

[15] Japan went metric during the early 1920s.

[16] The greater the depth of the explosion, the greater the force of the pressure wave.

ITALIA AND *LEPANTO*

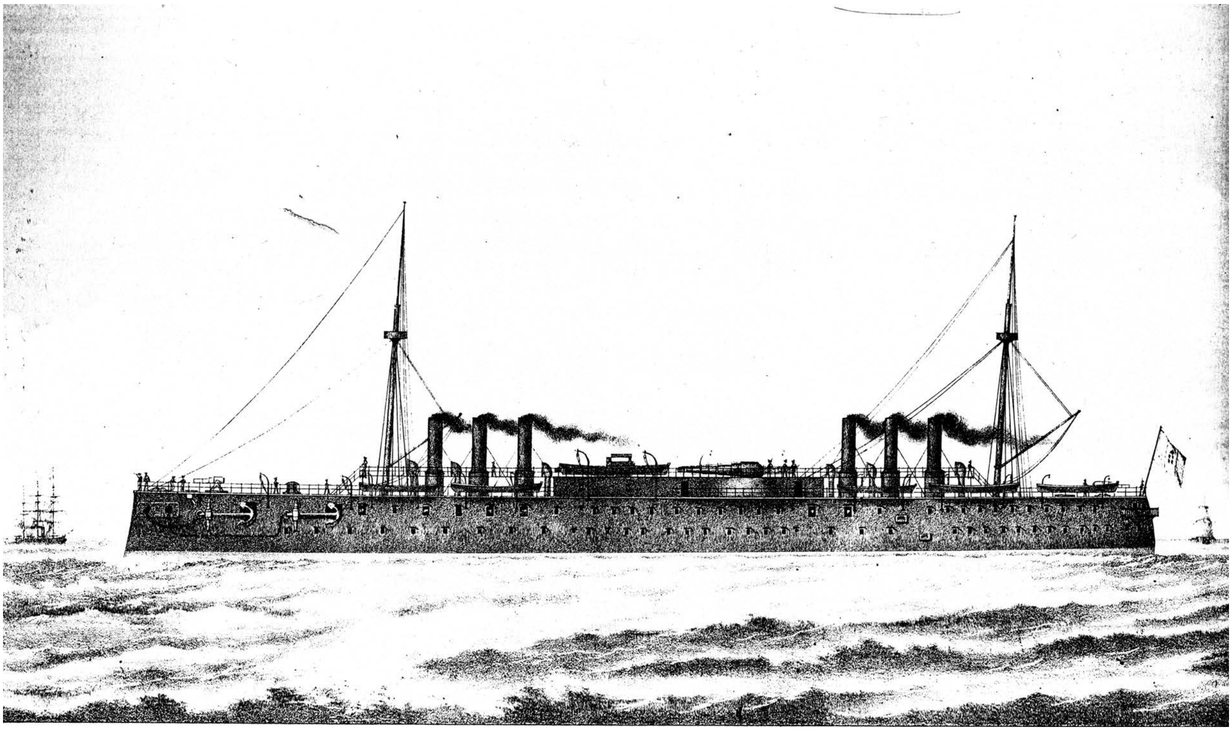
Giants of the Iron Century

The battleships *Italia* and *Lepanto* represented a radical solution to the conflicting needs of Italy's naval policy – ships that could not only fight a fleet action against enemy battleships, but also act as cruisers and as troop transports. Huge, fast, and armed with the most powerful guns in the world, they lacked the one attribute that had hitherto been a hallmark of all battleships: side armour. In this article **Sergei Vinogradov** describes these unique ships as well as the circumstances that led to their design.

Design and Construction

By the early 1870s the Italian Navy consisted of an unremarkable collection of ironclads, many of them built by foreign shipyards. That changed in 1873 when *Duilio* and *Dandolo* were laid down. These ships, designed by the brilliant naval architect Benedetto Brin, were revolutionary; when completed in the early 1880s, they mounted four 100-ton (450mm/17.72in) muzzle-loading guns in two turrets, arranged *en echelon* within a central citadel protected by massive thicknesses of steel armour. Fore and aft of the citadel, however, there was no waterline belt; the ships' stability and flotation were protected by a 51mm (2in) armour deck below the waterline and a cellular layer of small watertight compartments above it. There was no sailing rig, only a single military mast, but powerful machinery gave the ships a speed of 15 knots, 1–2 knots faster than contemporary foreign battleships. By any standard, they were a remarkable achievement.

Brin had an important ally in Admiral Simone Antonio Pacoret de Saint Bon, appointed Minister for the Navy in July 1873. Saint Bon was able to gain the support of Parliament for his ambitious naval programmes, and it was his political acumen, combined with Brin's genius, that would produce the even more radical *Italia* class. When the Naval Ministry announced its plans to build a second pair of giant battleships, strong opposition was voiced in Parliament, where many favoured the construction of small fast torpedo vessels. However, Saint Bon



Italia as originally designed, in an engraving from Masdea's 1880 book, *L'Italia: R. Nave di Prima Classe*. Note the vertical sides of the redoubt, the low position of the flying bridges and the two light masts. (Author's collection) overcame this opposition by arguing that these new ships would not only strengthen the fleet, but would also support Italy's political and colonial aspirations in the Mediterranean basin and beyond.[1]

The general concept of the new battleship design belonged to Saint Bon, who wanted a ship that would be 'long-ranged, fast and powerful'. These characteristics were shared by the *Duilio* class, but what would make the *Italia*s unique was a fourth requirement: the ability to transport a large body of troops to any threatened point along the Italian Kingdom's 3,940 miles (6,340km) of coastline. This followed from the Naval Law of 1 July 1877, which designated the fleet as the principal force in preventing an attack from the sea.

The original outline of *Italia*'s design was drafted personally by Brin in 1875. According to one of the designers, Eduardo Masdea (who would later design many Italian battleships and cruisers), '… originally *Italia* was designed for a main armament of two 100-ton guns [*ie* the 450mm model of the *Duilio* class], located in two armoured rotating turrets in a single breastwork with vertical sides of 45cm [17.7in]. Such a thickness was considered sufficient against the most powerful weapons of foreign fleets, such as the 81-ton [406mm/16in] guns of [the British battleship] *Inflexible*'.[2] By 1877 at the latest the main battery had been increased to four 100-ton guns.[3] In 1878, two years after the ships were laid down, it was decided to mount the latest heavy guns, the prospective 431mm (17in) Armstrong breech-loader. *Italia*'s designers also decided to abandon enclosed turrets, relying for protection on open barbettes within a central redoubt, with the guns firing over the parapet. This reduced topweight, and was probably a key factor in allowing an increase in freeboard and the insertion of a complete deck, which in turn provided the space for carrying a full infantry division of 10,000 troops.

Obviously any ship with these characteristics would be large, and Admiral Saint Bon's demand for the unprecedented speed of 18 knots drove the size up further. Both strategic and tactical considerations played a role in this requirement. At the strategic level, the Italian fleet, whose main force consisted of only a few modern units, needed to be able to concentrate as rapidly as possible at any point along Italy's extended coastline. At the tactical level Brin himself noted in a contemporary pamphlet that a slower group of smaller ships 'cannot overtake the single faster ship, and she can always be mistress of the situation and maintain herself in the front, in the rear, and on the flank of the group at whatever distance she pleases'.[4]

However, the most radical feature of *Italia*'s design was her complete lack of waterline armour. It was clear to Brin from the earliest stages of the design work that if he hoped to keep the ship's size within realistic limits, an extensive waterline belt, or even a limited citadel such as he had employed in *Duilio*, would be impossible. At the same time, many experts, including Carlo Albini in Italy and Andrew Noble (one of the directors of the Armstrong firm) in Britain argued that guns had gained such a superiority over armour that it was better to have none at all than to have plates that could be penetrated, since fragments of the plate would cause damage in addition to that from the projectile itself. These considerations led Brin to dispense with belt armour entirely; instead, *Italia*'s vitals would be protected by a continuous underwater armour deck from bow to stern, while flooding from any waterline hits would be limited by cofferdams, subdivision and coal bunkers. Vertical armour would be limited to protecting the main guns and other critical areas of the ship.

Despite abandoning waterline armour, the displacement rose as the design evolved from early concept to the ship as built. There were changes in the thickness and quality of the heavy armour plates and in the auxiliary armament; after the ship had been launched the original two light pole masts were replaced by a single military mast amidships, and a huge crane was added. As a result of these changes the ship's draught increased by 25cm (10in).

As had been the case with *Duilio* and *Dandolo*, foreign firms provided much of the equipment for the ships. The guns were all made by Sir WG Armstrong & Co, Elswick, the machinery by John Penn & Son, Greenwich. The manufacture of *Italia*'s armour was shared between the British firms of Charles Cammell & Co and John Brown & Co, both of Sheffield, while her sister ship *Lepanto*'s plate came from Schneider et Cie, Le Creusot, France, although some plates were made by Gio Ansaldo & C, Genoa. Much of the auxiliary equipment was also of foreign manufacture.

In 1875 *Italia* was assigned to the royal dockyard at Castellamare di Stabia, on the Bay of Naples, and in October 1876 *Lepanto* was ordered from the firm of Cantiere Navale Fratelli Orlando, Livorno. The decision to build this ship in a private shipyard provoked a heated debate in Parliament, where it was argued that she should be built by a state dockyard. Saint Bon justified the order by arguing that it would avoid significant delays, since the state facilities were already overloaded with the repair and modernisation of other ships.

On 29 September 1880, in the presence of King Umberto I, the cabinet of ministers, senators, deputies, the foreign diplomatic corps and fifty thousand spectators, *Italia* slid 'majestically and calmly into the sea upon which she will defend and preserve the fatherland whose glorious name she bears'. After launch the hull was towed to the opposite shore of the Bay of Naples, where her engines and boilers were installed. The ship was then

Table 1: **Construction Dates**

	Italia	*Lepanto*
Laid down:	3 January 1876	Oct/Nov 1876
Launched:	29 September 1880	17 March 1883
Completed:	16 October 1885	16 August 1887
Builder:	Cantiere di Castellammare di Stabia	Cantiere Navale Fratelli Orlando, Livorno

taken 350 miles to La Spezia, where the armour and guns were mounted, a process that took five years. *Italia* joined the fleet in October 1886 after more than four and a half years on the slipway and five years fitting out.

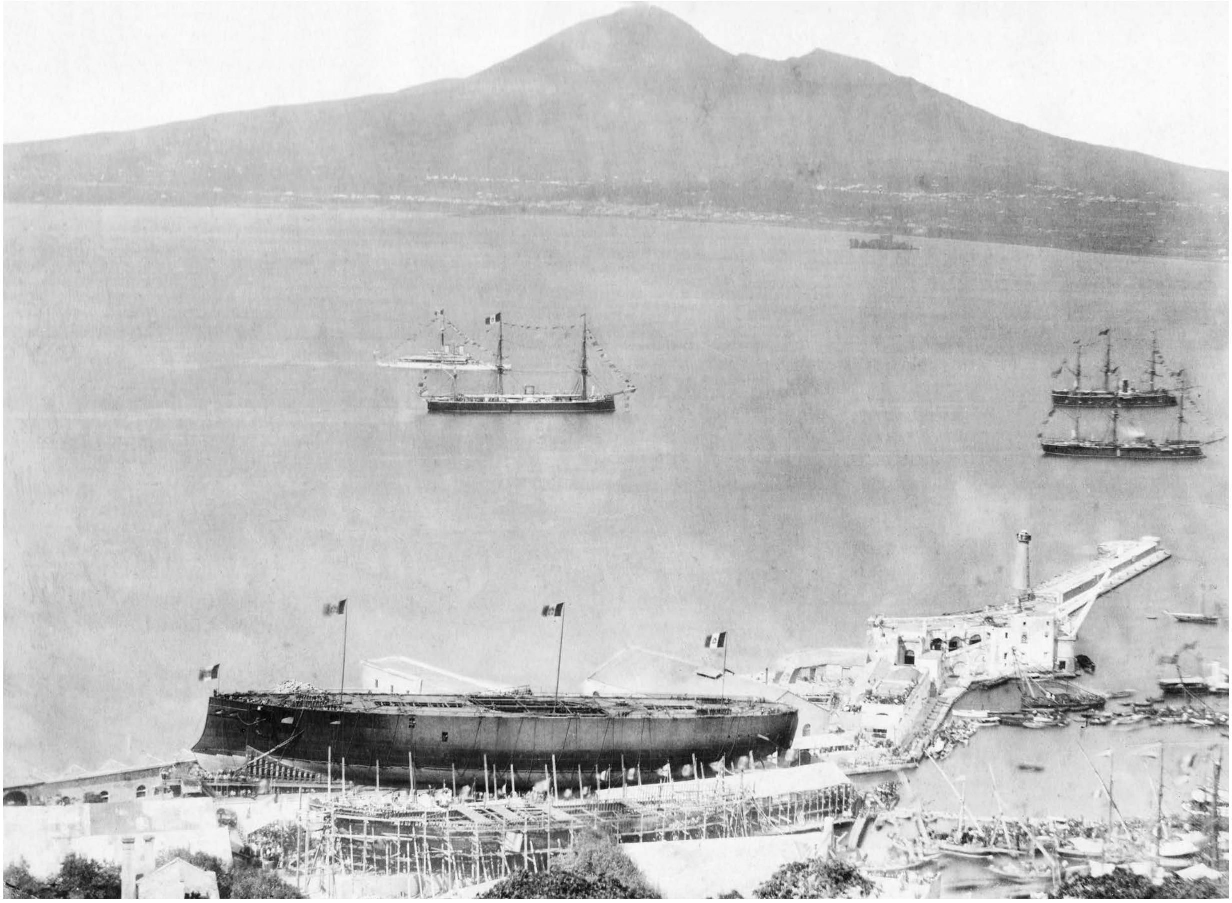
The construction of *Lepanto* at the Orlando shipyard began ten months after she was officially laid down[5] – this was a new private enterprise that was still preparing for this great responsibility. The ship's launch on 17 March 1883 was another ceremonial occasion: among those invited were the king and queen, the heir to the throne, princes, the British ambassador and many others. The launch arrangements had to be carefully worked out due to the very limited breadth of water available – about 600 metres (660 yards) from the end of the slipway to the opposite side of the harbour. A complex system of chain-retarders, which first dragged down the slipway and then along the bottom, prevented the ship from running right across the harbour.

The ship spent six and a half years (October 1876–March 1883) on the slipway, while another four and a half years were required for fitting out. She officially joined the fleet in August 1887. Thus, the entire process of designing and building the two great ships, from the working drawings in 1875 to *Lepanto*'s entry into service, was more than twelve years. Approximate cost (without additional expenditures on rearmament, alterations, etc) is officially given as 29,191,874 lire for *Italia* and 28,772,481 lire for *Lepanto*.[6]

General Features

Italia and *Lepanto* were built of steel, which allowed a 15 per cent saving in weight over comparable iron-hulled ships.[7] There was a double bottom extending over the entire length of the magazines and machinery spaces, that is, 77.55m, (254ft or 63.35% of the length between perpendiculars). The depth of the double bottom in the midsection was 1.0m (3ft 3in). The machinery layout followed the same basic pattern as that of *Duilio*: the engine rooms amidships, with boiler rooms fore and aft of them – an arrangement repeated in subsequent Italian battleships and cruisers. This had the advantage of ensuring that the boiler plant could not be put out of action by a single catastrophic hit, but it also required longer propeller shafts and the raising of the boilers in the after stokeholds so that the propeller shafts would have a clear run beneath them. The end result was an additional 120–150 tonnes of weight.

Structurally, the hull employed a longitudinal system that differed from the cellular system Brin had used in



Italia just before her launch on 29 September 1880. The ships visible out in the bay are the British *Dreadnought* and *Monarch* (left), and the Italian *Princeipe Amadeo* and *San Martino* (right). (Author's collection)

Table 2: **Characteristics as Designed and Completed**

	Italia	*Lepanto*
Displacement:	13,898t (13,679 tons) normal	13,550t (13,36 tons) normal
	*c*15,037t (14,800 tons) trials	
	15,654t (15,407 tons) full load	15,900t (15,649 tons) full load
Length:	122.00m (400ft 3in) pp	122.07m (400ft 6in) pp
	124.70m (409ft 2in) oa	124.70m (409ft 2in) oa
Beam:	22.54m (73ft 11in) wl	22.34m (73ft 4in) wl
Draught (mean):	9.12m (29ft 11in)	9.39m (30ft 10in) actual
Armament:	3 x 431mm/26, 1 x 431mm/27	4 x 431mm/27
	8 x 149mm/26	8 x 152mm/32
	4 x 355.6mm TT	4 x 355.6mm TT
Protection:	Compound armour	Steel armour
deck	102mm (4in; steel) max	76mm (3in)
redoubt	480mm (18.9in)	480mm (18.9in)
ammunition tube	400mm (15.75in)	400mm (15.75in)
funnel base	400mm (15.75in)	400mm (15.75in)
conning tower	300mm (11.8in)	300mm (11.8in)
Machinery:		
boilers	26 Admiralty oval	8 Admiralty oval, 16 locomotive
engines	4 x 3-cylinder vertical compound	4 x 3-cylinder vertical compound
horsepower	11,986ihp	15,797ihp
speed:	17.8 knots	18.4 knots
Endurance:	1,200 tonnes coal normal	1,600 tonnes coal
	3,000 tonnes coal full load	
	8,700nm at 10kts	
	(other sources give	
	5,000nm at 10 knots)	
Complement:	37 officers and 719 men	37 officers and 656 men

Duilio. In fact *Italia* was the first manifestation of the Italian preference for longitudinal hull framing, this system being adopted in all subsequent large ships. Of the nine continuous stringers on each side, V and IX were watertight. Three stringers on each side continued over the entire length of the ship.

Over the length of the double bottom the hull was divided by fifteen main transverse bulkheads and two longitudinal side bulkheads, which extended from the outer bottom to the protective deck, creating 51 watertight compartments. In addition, the four engine rooms (two to port, two to starboard) were divided by a centreline bulkhead. The hull fore and aft of the double bottom was subdivided into 18 compartments. There were thus 69 watertight compartments below the protective deck, plus another 84 in the double bottom.

The stem, of forged steel, terminated in a ram that projected 2.0m (6ft 7in). It was supported by a vertical bulkhead on the centreline and by the armoured deck, which curved down to the base of the ram. *Italia*'s underwater hull was sheathed with wood overlaid with zinc sheets to prevent fouling, while that of *Lepanto* was not sheathed. The ships had a very high freeboard, which provided the space needed to transport a full infantry division of 10,000 men.

Superstructures were minimal. The most prominent features were the funnels (six in *Italia* in two groups of three, four in *Lepanto* in two groups of two) and the single heavy tubular mast with a small fighting top for two 'anti-boarding' quick-firing (QF) guns, an arrangement similar to that in the *Duilio* class. The base of the mast served as the support for the boom of the main boat crane. *Italia* also had a large boat crane abaft the after funnel, while *Lepanto* did not. During *Italia*'s repairs in 1905–06 the heavy mast was removed and replaced with light, shorter masts, as had been intended in the original design.[8]

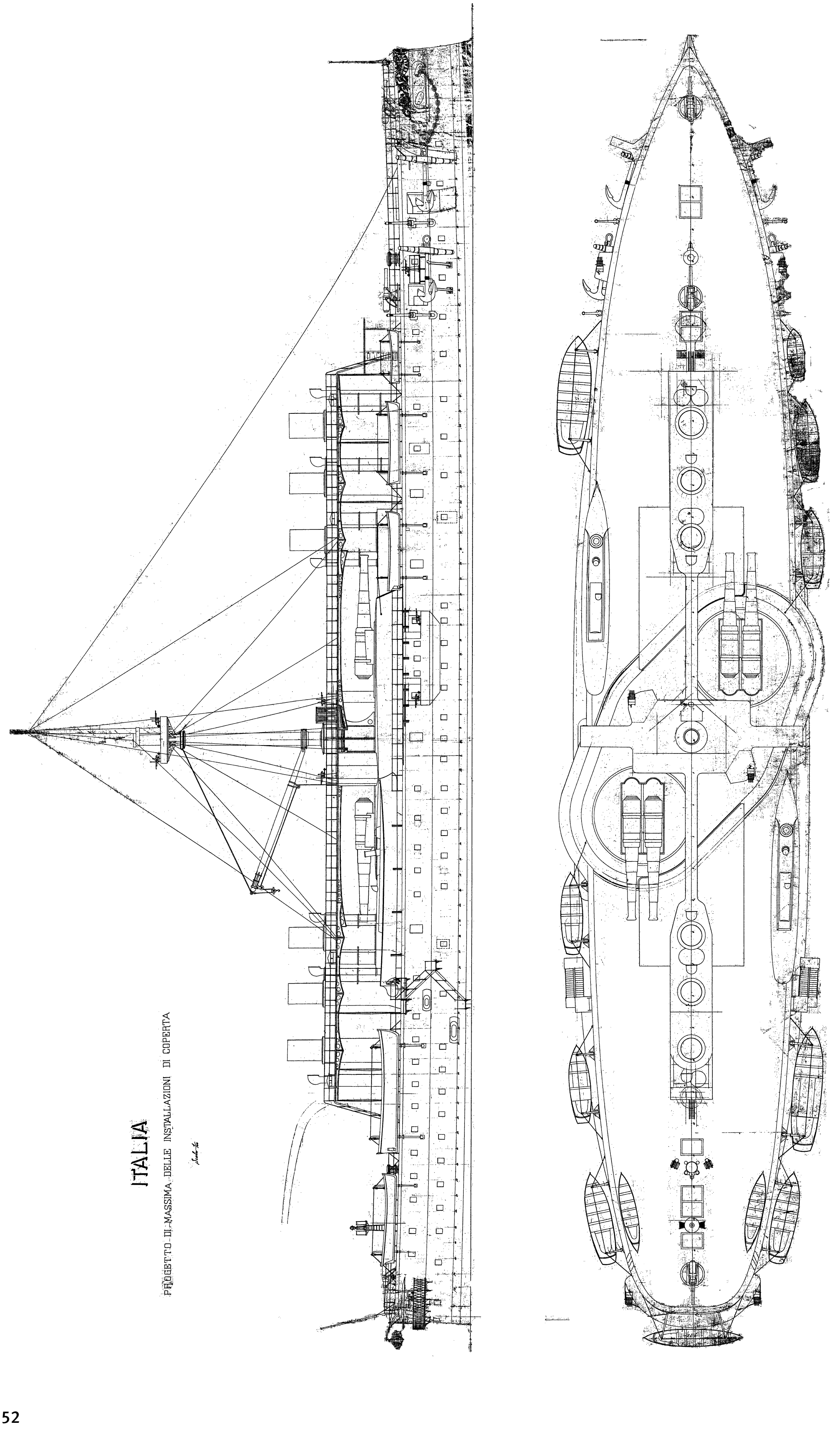
Table 3: **Weights**

Hull:	5,180 tons
Armament:	1,550 tons
Armour:	2,898 tons
Machinery:	2,400 tons
Coal (normal):	1,600 tons
Total:	**13,628 tons**

Note: These figures may not reflect the weights of *Italia* as built, which had a normal displacement of 13,679 long tons.

A narrow flying bridge ran above the upper deck from the forward to the after group of funnels, 12.5m (41ft) above the waterline. This height allowed the guns to rotate beneath it even at their maximum elevation.[9] There was a wheelhouse at the forward end of the bridge.

The steering gear arrangements were unusual. The rudder-head was located outside the hull 2.0m (6ft 7in) below the waterline, with a cross-head that was turned by means of two pistons that passed through stuffing boxes in the outer skin. Inside the hull, the pistons were


ITALIA
PROGETTO DI MASSIMA DELLE INSTALLAZIONI DI COPERTA
Scala 1/100

Outboard Profile and Plan. (Official plans dated La Spezia 25 July 1892) connected by another cross-head. *Italia*'s gear was steam-driven, while *Lepanto*'s was hydraulic; manual back-up was provided in both cases. The peculiar design allowed the elimination of a stern overhang, a necessity in view of the limited size of available Italian docks. One authority noted that the system provided the steering gear with excellent protection and at the same time saved at least 30 tonnes of weight.[10]

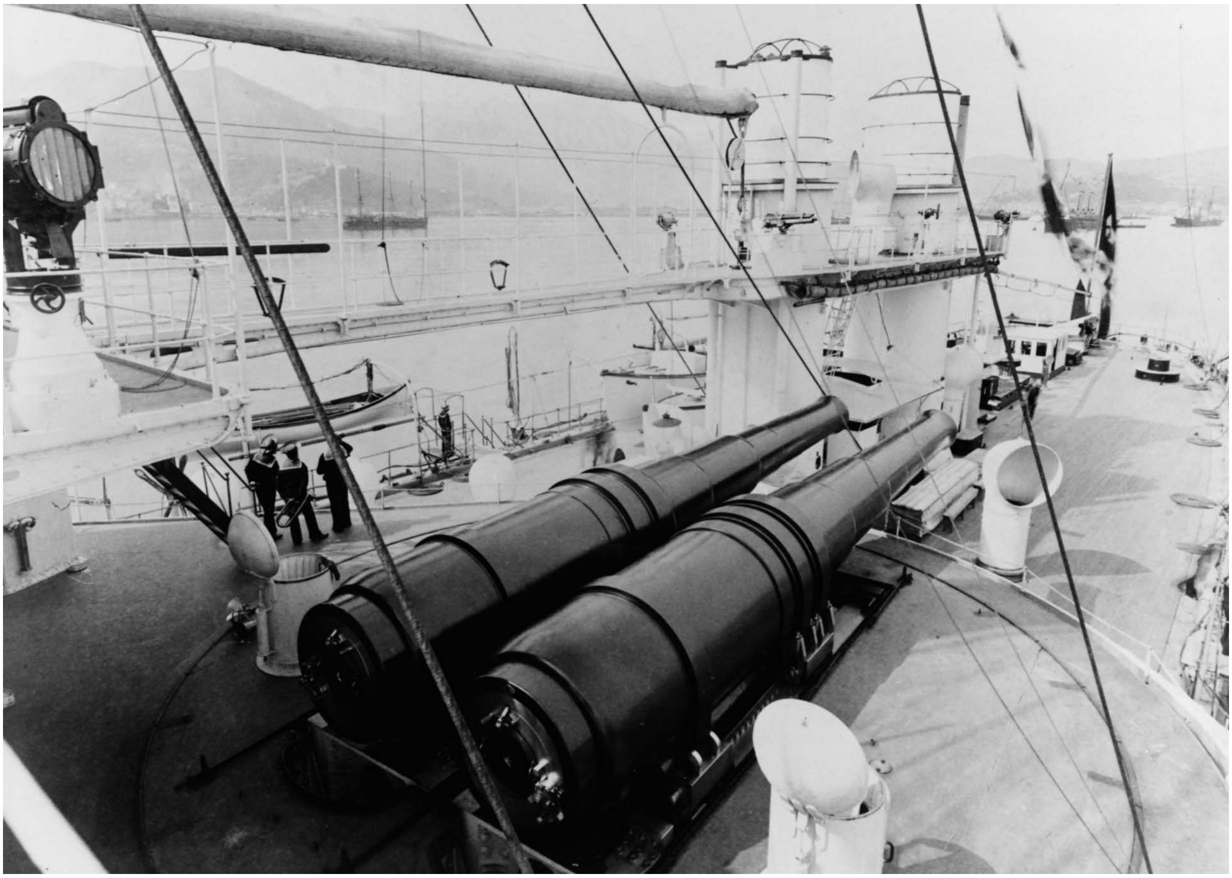
The ships had excellent lines, thanks in part to model tests of *Italia*'s hull by Edmund Froude at Torquay.[11] William White, the chief constructor of the Royal Navy, noted that 'some of the most beautiful forms ever produced by the naval architect are hidden from sight below the water-line' of these ships.[12]

Lepanto's trials revealed some unpleasant features, which were probably inevitable in such a novel warship. One contemporary report stated that the ship was 'not sufficiently stable', and that she required a good deal of ballast. Moreover, when all the 431mm guns were trained on one broadside the ship took on a list of 11 degrees.[13]

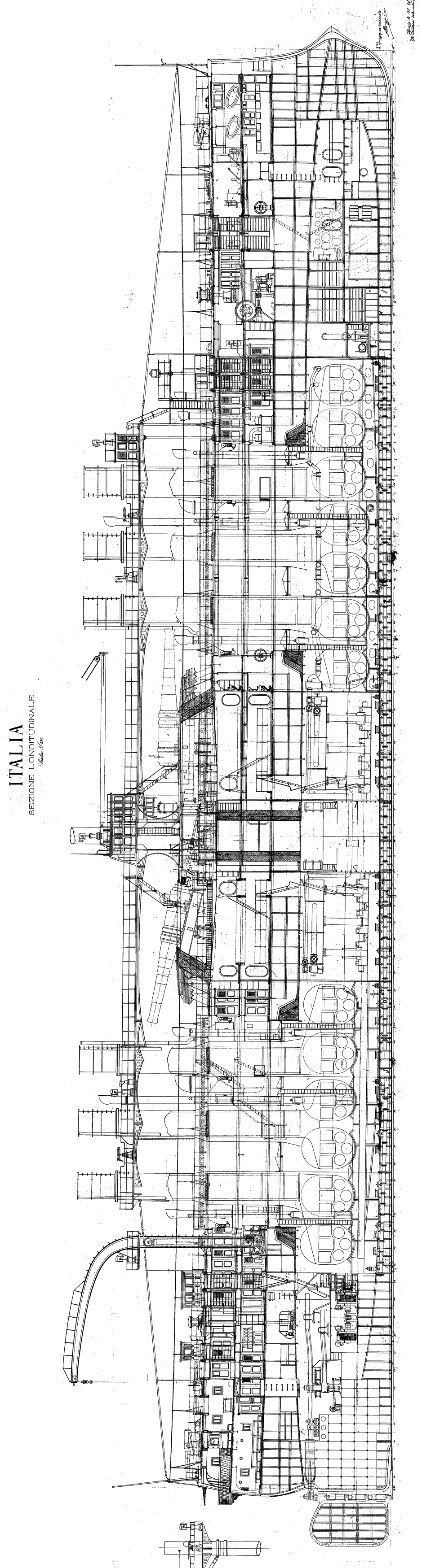
Armament

In February 1875 General Rosset, a prominent Italian artillerist, argued that for the same weight as the 450mm (17.7in) gun that armed *Duilio* and *Dandolo*, a 431mm (17in) gun could be made with a longer barrel. Using the new slow-burning powders, such a gun could provide a significant increase in the muzzle velocity of the projectile, thereby improving its armour penetration.[14] Rosset's proposal had no immediate effect, and four muzzle-loading 450mm guns were ordered from Armstrong for *Italia* and *Lepanto*. However, in 1878 the British government purchased the guns in response to an Anglo-Russian war scare, mounting them at Gibraltar and Malta. The Italians did not protest against this diversion, however, as Armstrong had already reported that it was developing a more powerful 431mm breech-loading gun along the lines Rosset had outlined. Construction of the new ships had only just started, and Armstrong promised to meet the 100-ton weight of the previous model, so the Italians decided to adopt the newer gun.

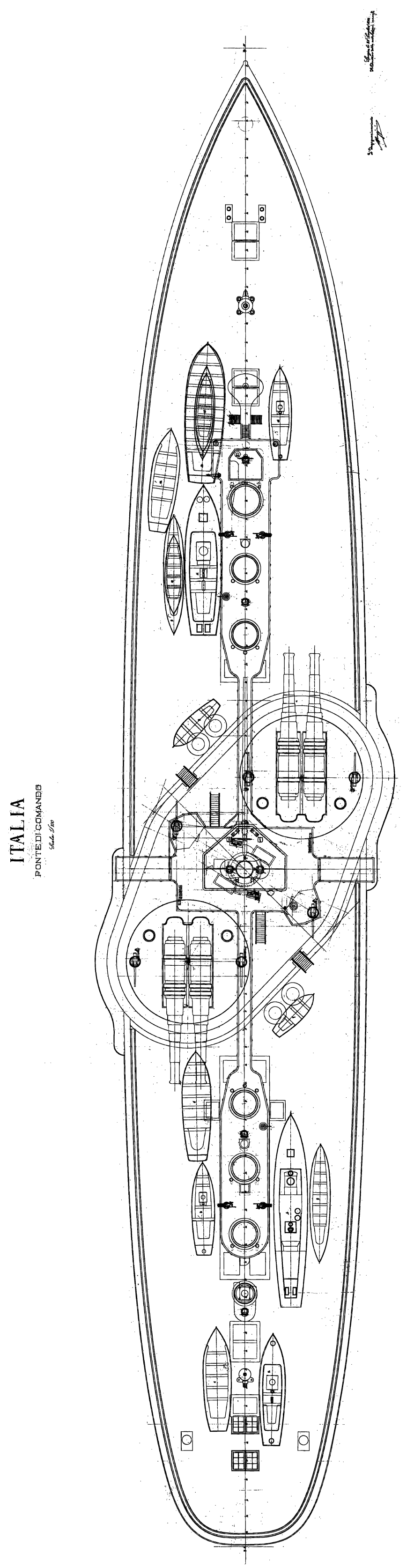
Rosset's predictions were borne out by the 431mm guns: despite their smaller bore, they were indeed more powerful than the 450mm guns of the *Duilios*. Those 20-calibre pieces fired a 907kg (2,000lb) projectile at an initial velocity of 472m/s (1,550ft/s), whereas the new 431mm/26 guns fired a projectile of the same weight at velocities of up to 600m/s (1,970ft/s). The new guns were also breech-loaders, which greatly simplified the loading arrangements.



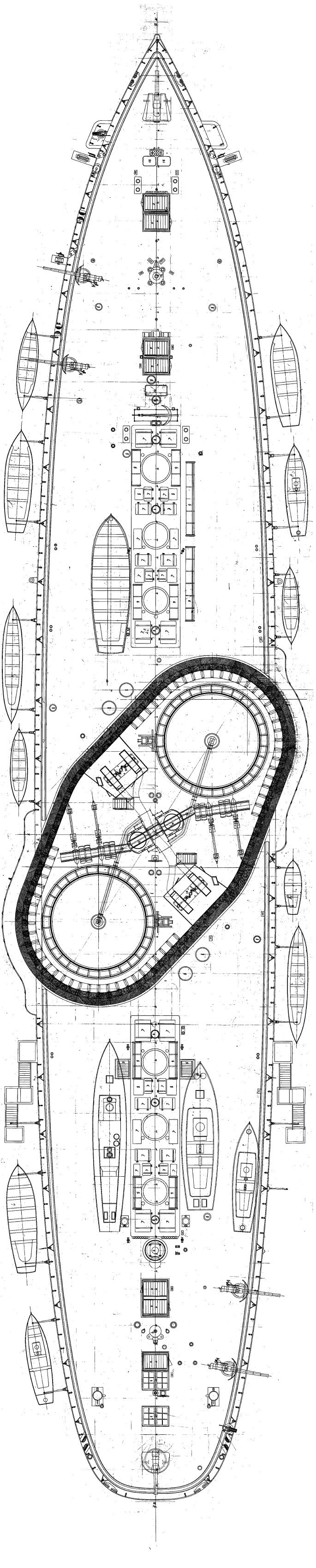
The 431mm guns of *Lepanto's* portside barbette in 1887. The 30mm protection over the top of the barbette is in evidence, as is the searchlight on the bridge to the left. Just visible on the after flying deck are 37mm Hotchkiss revolving cannon. (Author's collection)


ITALIA
SEZIONE LONGITUDINALE
Scala 1/100

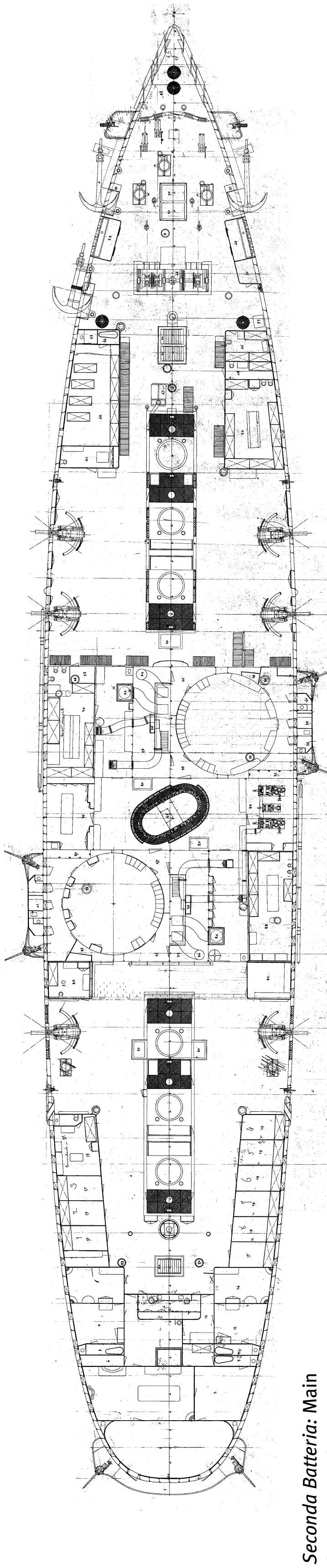
Inboard Profile.


ITALIA
PONTE DI COMANDO
Scala 1/100

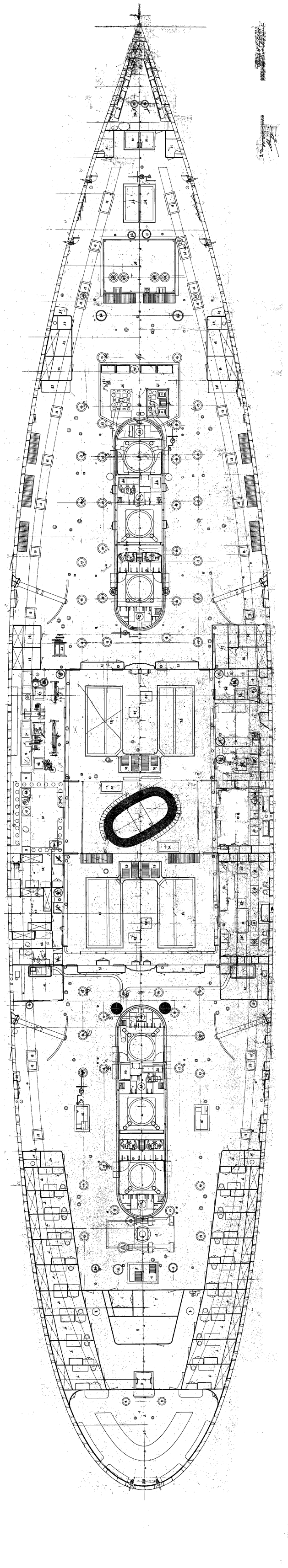
Ponte di Comando: Bridge Deck Plan.


ITALIA
PIANO DI COPERTA E INTERNO RIDOTTO

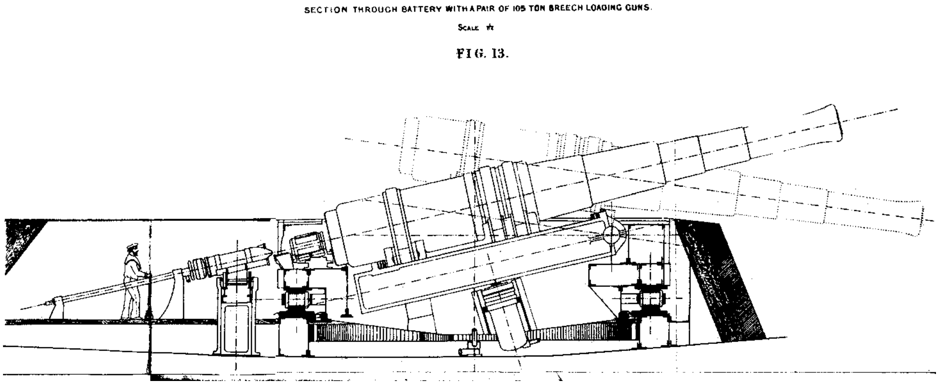
Coperta e Interno Ridotto: Plan of Upper Deck and Central Redoubt.



Seconda Batteria: Main ('2nd Battery') Deck Plan.



Prima Batteria: Lower ('1st Battery') Deck Plan. (Official plans dated La Spezia 25 July 1892)


SECTION THROUGH BATTERY WITH A PAIR OF 105 TON BREECH LOADING GUNS.
Scale
FIG. 13.

A drawing of the loading arrangements for the 105-ton, 17in gun first published in *Transactions* of the Institution of Naval Architects, Vol XXIX (1888), plate XI.

The guns were of the built-up type in common use at that time; their construction was described in a contemporary article:

> … the ['A'] tube is in two parts, held together longitudinally by a key-ring in halves. The breech-screw plays in the tube, over which is shrunk a steel breech-piece supported by two layers of thin hoops, and a thick outer wrought-iron coil. The middle and forward parts of the tube are supported partly by steel hoops and partly by wrought-iron coils.[15]

The reinforcing hoops were heated and then placed over the breech end of the gun; they shrank as they cooled, which created an inward stress that partially counteracted the expansive forces produced when the gun was fired. The breech block itself was of the interrupted screw or 'French' type. Before the guns were mounted in *Italia* the prototype was subjected to extensive testing to determine the best combination of shell and propellant.[16]

In 1881 an improved model, the 431mm/27, was developed; the overall construction of the gun was modified, and the gun was made entirely of steel.[17] It was a more powerful weapon, with a muzzle energy of 55,030ft-tons as opposed to the 51,930ft-tons of the 431mm/26. For reasons that are unclear *Italia* was armed with three 431mm/26 and one 431mm/27 gun. Given the short battle ranges of the era, the different ballistics of the guns would have had little effect. *Lepanto* had a uniform armament of four 27-calibre guns.

The biggest fault in both models was the two-part 'A' tube. While cleaning *Italia's* guns after a gunnery practice in the late 1880s, the crew discovered that water was leaking out from inside the bore through the joints in the external tubes. The guns by this time had fired no more than 50 rounds.

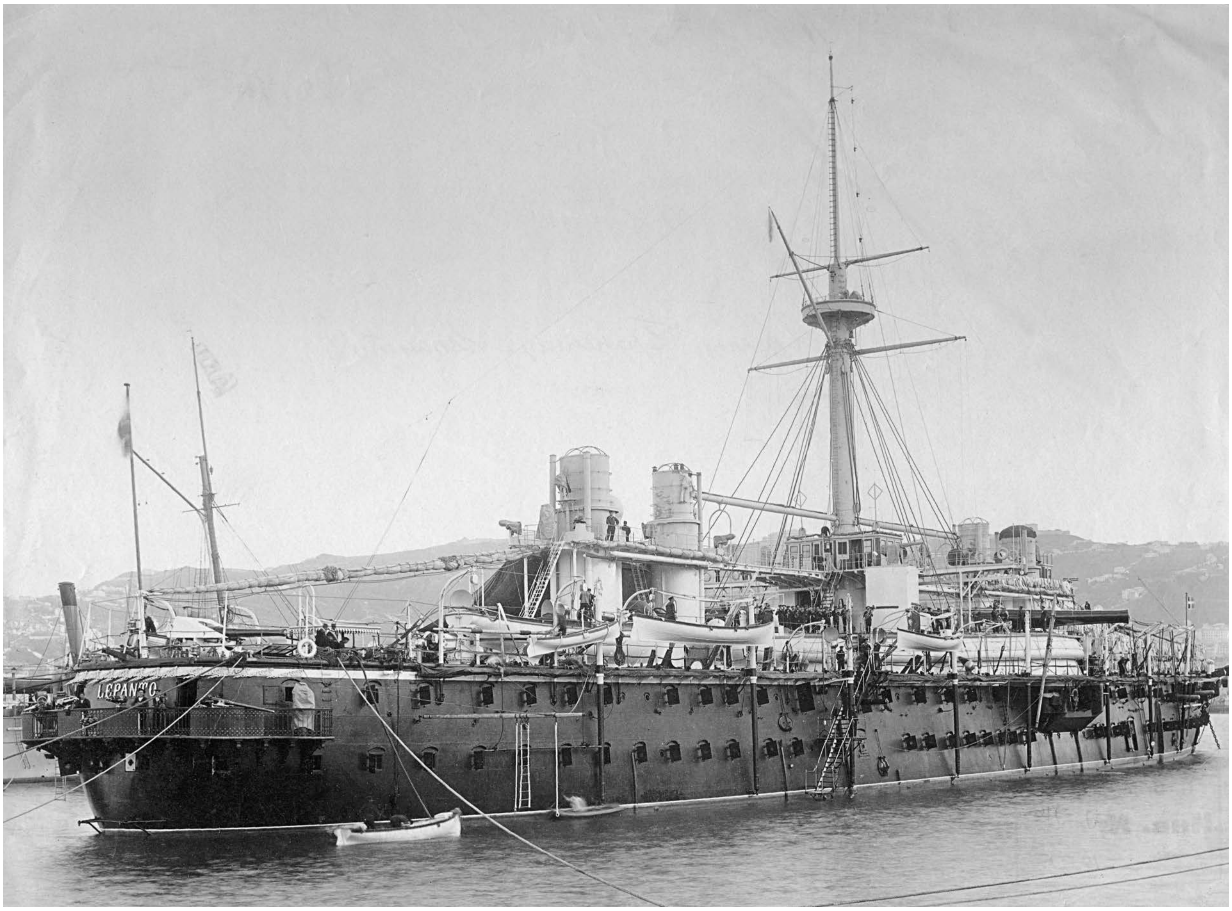
The mounting for the 431mm guns was designed under the guidance of Armstrong's George W Rendel, who patented it in December 1878.[18] The guns had no trunnions, but six protruding ridges on the casing fitted into corresponding grooves on the cradle and prevented any movement of the barrel, while three metal bands held the barrel to the cradle. Hydraulic compressors absorbed the recoil.[19] The guns had a maximum elevation of +15 degrees and a maximum depression of -10 degrees. A contemporary book explained these limits: 'the barrels of the *Italia*'s guns are about 10m [33ft] above sea level, so an enemy's waterline remains vulnerable to fire on the broadside even if it closes to 55m [60 yards], while at 12° elevation [the battleship] is able to hit a fort at a height of 450m [1,475ft] above sea level from a range of 3,000m [3,280 yards]'.[20]

The two barbettes were arranged *en echelon*, allowing

Table 4: **The Guns of *Italia* and *Lepanto***

	17in/26 BL	17in/27 BL	152mm/32 QF	149mm/26.7 QF	120mm/40
Designation:	431 C	431 B	152 C	149 A	120 A
Calibre:	17.7in/431mm	17.7in/431mm	6in/152mm	5.9in/149mm	4.7in/120mm
Weight:	103 tons	100 tons	5.4 tons	4.25 tons	2.05 tons
Barrel length:	468in/11,887mm	489in/12,421mm	201in/5,105mm	166in/4,216mm	194in/4,928mm
Bore/rifled length:	315.7in/8,019mm	346.8in/8,809mm	32.1 cal	26.7 cal	40 cal
Projectiles and performance:					
Weight, AP:	2,002lb/908.1kg	2,002lb/908.1kg	97.6lb/44.3kg	82lb/37.2kg	45lb/20.4kg
Charge:	722lb/327.5kg	827lb/375.1kg	46lb/20.9kg	33lb/15kg	12lb/5.4kg
MV:	1,811f/s (552m/s)	1,903ft/s (580m/s)	1,952f/s (594.9m/s)	1,903f/s (580m/s)	1,786f/s (544m/s)
Penetration at muzzle (wrought iron):	37.6in (955mm)	39.4in (1,001mm)	14in (356mm)	11.8in (300mm)	–

Source: *Italy, War Vessels and Torpedo Boats*, 1897.



Lepanto at Genoa on 17 August 1887, soon after entering service. The 57mm guns on the sternwalk can just be made out, while the 37mm revolver cannon on the flying bridge have canvas covers over them. Note also the rolled-up awning wrapped around the line running down from the flying deck to the ensign staff at the stern. There was a similar awning line forward. (Author's collection)

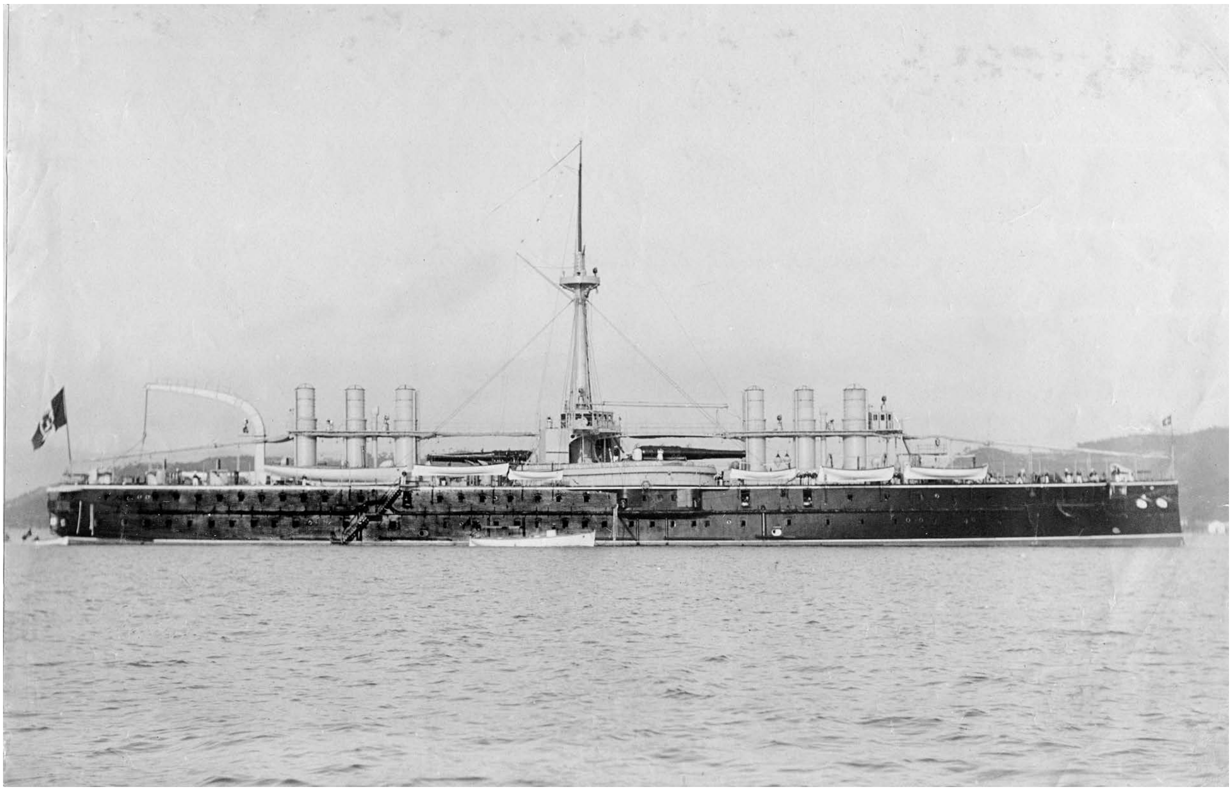
an arc of fire of about 45° on the opposite side of the ship. The guns loaded at a fixed position – at an elevation of +15° and a fixed angle of train: 45° off the bow for the starboard mounting, 45° off the stern for the port mounting. The projectiles and charges were pushed into the breech by telescopic rammers. Rate of fire is given as one round every eight minutes, but it is not clear if this included the time needed to bring the guns to their loading position and then aim them again after loading; another source gives fourteen minutes as the time between aimed shots.[21] The ammunition outfit of the 431mm guns is given as fifty rounds per gun in a Russian source, while the British Royal Navy's Intelligence Department believed that *Italia*'s outfit was 45 rounds per gun, and *Lepanto*'s 40 rounds.[22]

As designed, the secondary armament of both *Italia* and *Lepanto* was to comprise eighteen 149mm (5.9in) 26-calibre Armstrong guns, model 1880. Twelve of them, on Albini mountings, were to be located six on either side on the main deck, with four more on the upper deck along the sides of the breastwork, while the last two were also to be on the upper deck at the bow and stern on the centreline. As completed, however, the secondary batteries of the two ships differed from the original plans and from each other. *Italia* entered service with only eight 149mm guns, two on the upper deck (one right forward, the other right aft), and three on either side on the main deck (two forward of the redoubt, one aft).[23] *Lepanto* had eight 152mm/32 guns on Vavasseur mountings similarly disposed. The guns on the upper deck had shields, but the only protection for those on the main deck was the ship's hull plating.

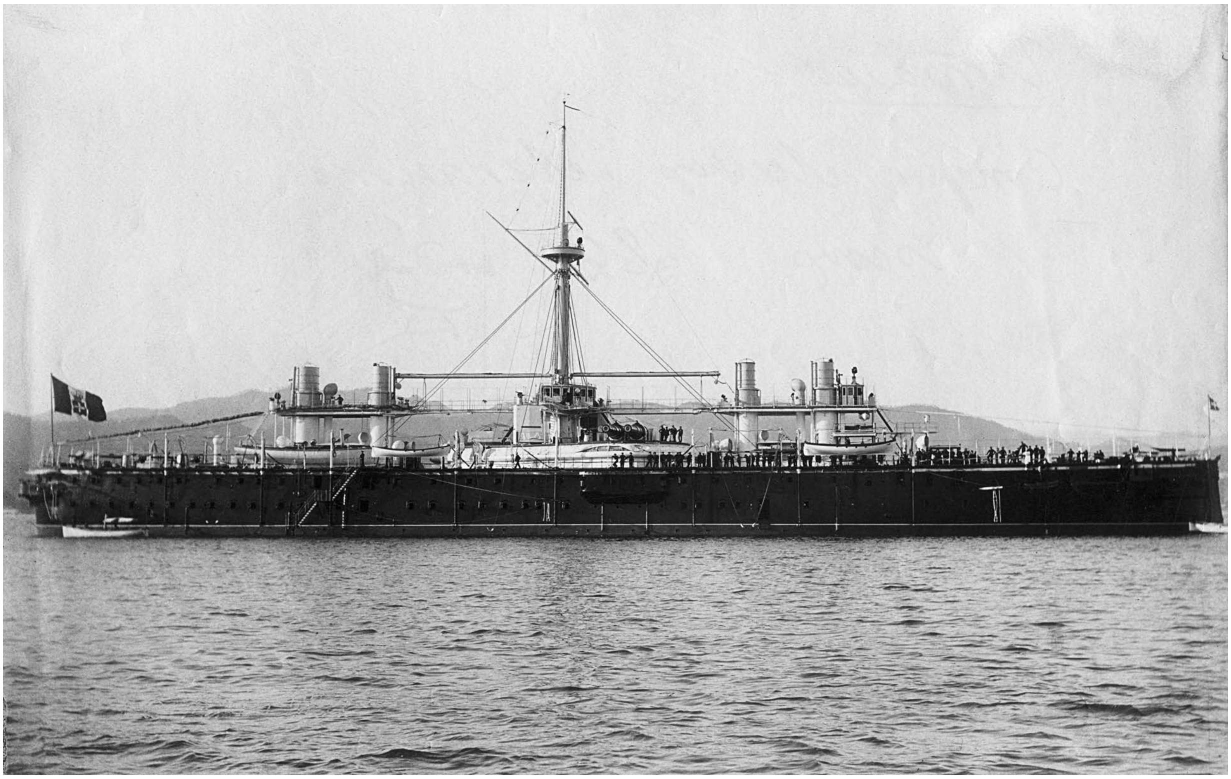
While the main armament of both ships remained unchanged throughout their service, the secondary and light batteries of both ships were altered and supplemented over time. These changes are summarised below:[24]

Italia:

– by 1890: 8 x 149mm/26, 4 x 120mm/32 QF
– by 1900: 8 x 149mm/26, 4 x 120mm/32 QF, 12 x 57mm/40 QF, 12 x 37mm/25.4
– after 1900–08 modernisation: 7 x 152mm/32, 6 x 57mm/40 QF, 2 x 37mm/25.4
– 1915 (floating battery at Brindisi): All secondary and smaller guns removed
– 1918 (grain transport): 2 x 120mm/32 (17in guns removed at this time)



Italia after the addition of the 120mm guns. Two were located on the upper deck on the port side forward, the other two on the starboard side aft, just visible in this photo. (Author's collection)



Lepanto in 1892. The starboard pair of 431mm guns are trained almost directly at the camera. The framework to support the awnings over the guns can just be made out. (Author's collection)

Lepanto:
- by 1890: 8 x 152mm/32, 4 x 120mm/32 QF
- by 1900: 8 x 152mm/32, 4 x 120mm/32 QF, 12 x 57mm/40 QF, 12 x 37mm/25.4
- 1911: 4 x 120mm/32 QF, 9 x 57mm/40 QF, 6 x 37mm/25.4, 2 MG

At some point *Italia*'s 149mm guns were converted to quick-firing guns. In both ships the 120mm (4.7in) guns were located on the upper deck, two on the port bow and two on the starboard quarter. The positions of the lighter guns are difficult to determine, but from drawings and photographs it appears that two 57mm guns were mounted on the main deck in each of the sponsons under the redoubt, two on the sternwalk, two on each barbette roof beside the 431mm guns, and two on the flying deck near the conning tower. Several of the 37mm guns were also located on the flying deck, while two were in the small fighting top. Others were on the main deck, able to fire through ports on the broadside, and two were mounted in small sponsons near the bow. Both ships also carried two army-pattern 75mm mountain guns and two machine guns, for use by landing parties.

The torpedo armament of both ships consisted of four 355.6mm (14in) above-water broadside tubes; these could be trained from 50 degrees to 20 degrees before the beam. An underwater tube in the bow was either soon removed or never installed. *Italia* is listed as carrying six torpedo tubes after her 1900–08 modernisation, but this seems unlikely. By 1911 *Lepanto*'s torpedo tubes had been removed.

In addition to her other armament, *Italia* carried two second-class torpedo boats, while *Lepanto* carried three 12.8m (42ft) picket boats each of which could be armed with a torpedo tube or a 57mm gun.

The ships were equipped with several Mangin searchlights mounted at the bow and stern, as well as along the sides on the bridge wings. Their tests, according to the Russian naval attaché in Italy, 'gave results poorer than expected'.[25]

Protection

Describing the protection of these ships presents many difficulties; both contemporary and modern sources quote different thicknesses for every element of the armour protection scheme. This is especially true of the armoured deck, which is reported to have been anything from 3in (76mm) to 120mm (4.7in) thick. This particular disagreement can be reconciled to some degree if, instead of having identical deck protection, *Italia* and *Lepanto* differed from one another, as stated in the British Naval Intelligence Department's description of the ships.[26] According to this source, *Italia* had a 102mm (4in) steel deck amidships, probably extending from the foremost to the after boiler room; the deck was then thinned to 76mm (3in) fore and aft. *Lepanto*, on the other hand, is shown with a uniform 3in steel deck over her entire length. The armour was laid on 15mm (0.6in) deck plating.

The armour deck divided the hull horizontally into a lower half, containing the machinery, magazines, steering gear, etc, and an upper half, housing the crew's quarters, coal bunkers, and stores. The crown of the deck was about 0.9m (3ft) below the waterline, curved downward to about 1.95m (6ft 5in) below the waterline at the sides amidships. At the bow it ran downward to support the ram.

The monster guns of the era fired slowly, and their projectiles were often solid shot, since explosive shells could not penetrate heavy armour. The design of *Italia* and *Lepanto* therefore made use of several constructional features intended to protect their buoyancy and stability against relatively infrequent hits by such shot. Along each side of the hull above the armour deck there were two cofferdams, formed by longitudinal bulkheads and extending about 1.5m (5ft) above the waterline. The outer cofferdam, located a few feet inboard of the outer hull, was filled with cork, which was intended to limit the flooding if the hull was pierced at the waterline. The inner cofferdam, 0.9m (3ft) wide, was subdivided by partitions and could be accessed from above through manholes; holes in the outer cofferdam could be blocked by stuffing hammocks or similar materials into the inner one.

Running across the breadth of the ship between the inner cofferdams was the cellular layer (*ponte cellulare*), topped by a flat unarmoured deck. This space was further divided horizontally by an intermediate deck, about 0.4m (16in) above the waterline. The upper half was subdivided into 154 sealed ('blind') compartments, while the lower portion was subdivided into 188 compartments filled with coal, which would limit the floodable volume if the hull were damaged.[27]

The two ships differed in the armour plate used for their vertical protection. By the late 1870s wrought iron was no longer effective in resisting the ever-more-powerful guns and 'chilled' (hardened) projectiles that were entering service. All-steel plate was one alternative, but while it was harder than wrought iron, it was also more brittle, showing a tendency to break up when struck by heavy projectiles. Nevertheless, after competitive trials at La Spezia in 1876 all-steel plate made by the French firm of Schneider et Cie had been selected for *Italia*'s predecessors, *Duilio* and *Dandolo*. Soon afterwards, however, 'compound' armour, featuring a hard steel plate fused to a soft but tough wrought iron backing, was developed independently by two British companies, Cammell and John Brown. In both cases the steel plate was about one-third the total thickness of the plate, giving a 25% improvement over wrought iron in resisting projectiles. In November 1882 a new round of trials was held at La Spezia to determine the best type of plate for the armour of *Italia*. Despite the fact that the all-steel seemed to show superior resistance, compound plate from both Cammell and John Brown was selected for *Italia*'s heavy armour. The new Navy Minister, Rear Admiral Ferdinando Acton, justified the choice in Parliament by stating that 'the imperfect bolting and soft backing placed the compound plates at a disadvantage, and did not represent such rigid support as would be afforded by a ship's side', and that in foreign trials compound plates had shown superior resistance.[28] However, only two years later, in October 1884, yet another series of trials was undertaken at La Spezia to decide which type of plate to use for *Lepanto*. By this time Schneider had further improved its all-steel armour, and on this occasion its superiority over compound could not be denied, so *Lepanto*'s heavy armour was supplied by the French firm.[29]

Despite the different types of armour, the two ships were protected by similar thicknesses of plate. The barbettes of the 431mm guns were protected by a redoubt set diagonally across the upper deck amidships and projecting slightly beyond the hull sides. It was protected by 480mm (18.9in) plates, sloped at 25 degrees from the vertical, on a teak backing 521mm (20.5in) thick.[30] To protect the men working the guns against 'fire from high-placed forts', the tops of the barbettes were covered by 30mm (1.2in) plating, made up of two layers of 15mm (0.6in). The redoubt measured 29.3m (96ft) by about 16.1m (53ft), and its enormous weight – some 900 tonnes, including 114 tonnes for the teak backing – was supported by four longitudinal and four transverse bulkheads extending through the entire depth of the hull. These bulkheads were structural and were not part of the ship's watertight subdivision; in fact they had oval apertures without doors to allow unimpeded passage.[31]

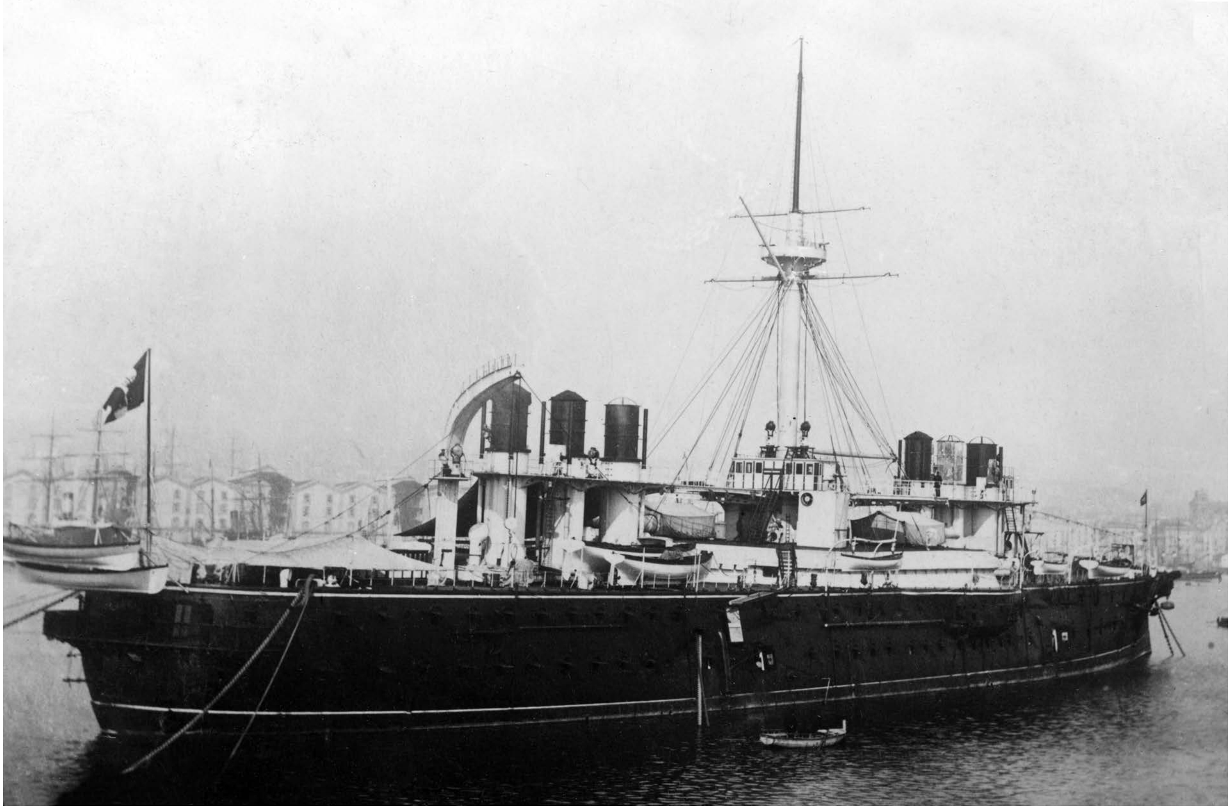
Ammunition was brought up from the magazines by a supply tube that ran between the armour deck and the centre of the redoubt. It was protected by 400mm (15.75in) plates.[32] Also rising from the armour deck were the two groups of funnel uptakes, each protected to a height of 0.9m (3ft) above the waterline by armoured glacis; these consisted of inclined 400mm (15.75in) plates.

There was a conning tower on the flying bridge at the base of the mast; it was a cylinder 1.46m (4ft 9in) high with sides 300mm (11.8in) thick.[33] It was equipped with a steering wheel and voice tubes for communication with all combat posts and the engine and boiler rooms.

Machinery and Trials

The designed speed of 18 knots was unprecedented in a ship of this size, requiring an estimated 18,000ihp. This power was to be developed by four identical three-cylinder engines, two per shaft. The engines could run in an economical compound mode for normal cruising and in direct-acting mode for high speeds.[34] Each engine was in its own compartment, providing increased survivability, and each had the following characteristics:

Cylinder diameter:	1,372mm (54in)
Piston stroke:	991mm (39in)



Italia early in her career. Note the tent-like awnings over the 17in guns, and the searchlight mounted on the big crane aft, with others on the after flying deck and atop the wheelhouse. (Leo van Ginderen collection)

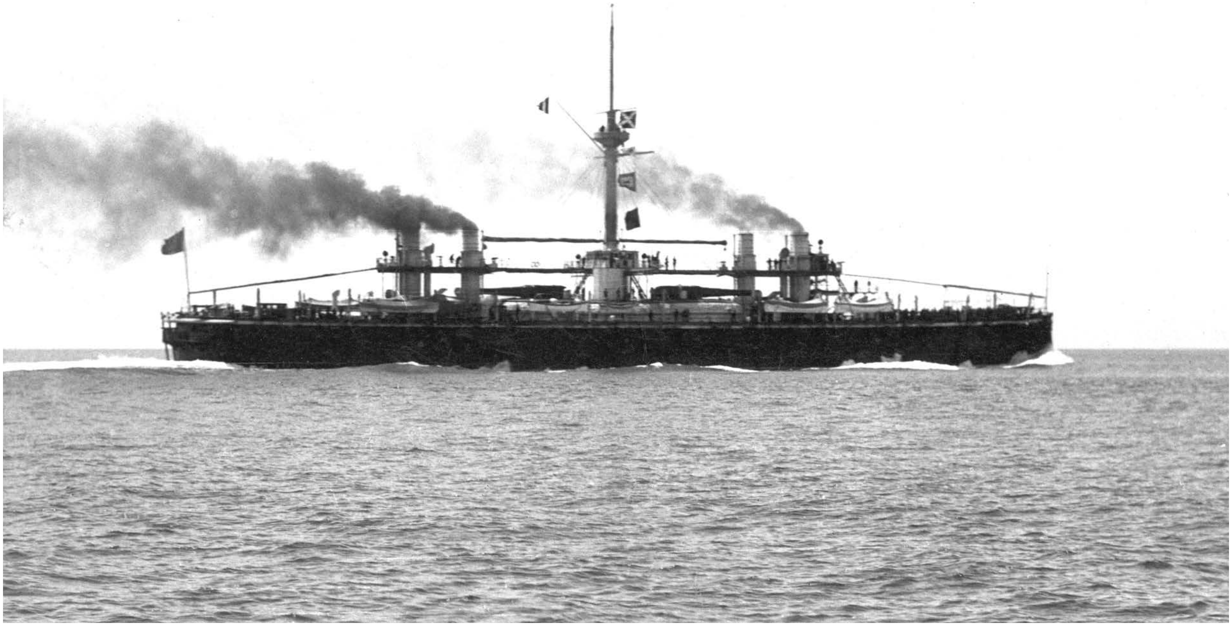
Italia had 26 Admiralty oval fire-tube boilers, a space-saving variation on the standard cylindrical boiler. Forward of the engine compartments there were three boiler rooms; the foremost compartment contained six boilers, the other two compartments had four each. Aft of the engines there were again three boiler rooms, with four boilers in each, for a total of twelve. Steam from any boiler could be directed to any of the four engines. Working pressure was 4.2kg/cm^2 (60psi), total grate area of all the boilers was 144m^2 (1,551ft^2), total heating surface 4,637.7m^2 (49,920ft^2). Each boiler room was served by its own funnel.

According to her contract, *Italia* was to develop 18,000ihp with forced draught, for a speed of 18 knots. However, the ship never reached this speed. Her trials began in December 1885, and towards the end of March 1886 the Italian press reported a speed of 17.85 knots, but in reality she did not exceed 17.5 knots, and was able to maintain even this speed for only about an hour.[35] The ship reached 17.4 knots at 13,500ihp and 86–88rpm on a subsequent four-hour run. The maximum output ever recorded for her machinery was 15,907ihp, but even so she could not reach 18 knots.

Italia's inability to make her contracted speed was attributed to the small steam capacity of her boilers and to insufficient ventilation, which led to excessively high temperatures in the boiler rooms. In addition, with forced ventilation running at full power so much coal dust was blown about by the fans that the stokers had difficulty breathing. Improvements in ventilation were made difficult by the cramped layout of the stokeholds.[36]

Possibly because of *Italia*'s disappointing trials, *Lepanto* had a different steam plant. There were only eight oval boilers, four in each of the compartments immediately before and after the engine rooms; the other four boiler rooms each had four locomotive boilers. This type of boiler was often used in torpedo boats, and could be forced to a greater degree than other boilers. Whereas the air pressure in the oval boiler rooms could be as high as 63.5mm (2.5in) of water, in the locomotive rooms it reached 102mm (4in). This meant that a smaller area of grate could burn more coal, but as one historian has noted, 'Locomotive boilers as fitted in steam vessels were particularly liable to fail … No complete remedy was ever found …'.[37] In *Lepanto*'s case, however, they proved successful, at least during her machinery trials. The combined grate area of *Lepanto*'s oval and locomotive boilers was 107.2m^2 (1,153.6ft^2), the total heating surface 3,909.4m^2 (42,080ft^2).

In *Lepanto* the oval and locomotive boilers were served by separate funnels, resulting in only four funnels, instead of six as in *Italia*. The forced-draught fans were rearranged to improve ventilation and eliminate the problem of coal dust being blown up from the floor-plates. The changes proved successful; during her trials in April–May 1888 she reached 18.38 knots at 93.5rpm, although the machinery developed only 16,150ihp instead of the contracted 18,000ihp. The locomotive boilers were regarded as particularly successful, although they did require more careful supervision than the oval type. During the trials the mean temperature of the oval boiler stokeholds was 41 degrees Celsius (106° F), while that in the locomotive boiler rooms was only 31 degrees C (88° F), and the trials were carried out with the ship's own stokers rather than picked men, as was often the case with ships built in private yards.[38] The trials were then discontinued, apparently because the ship was due to be commissioned.



Lepanto running at speed, possibly during her trials. (Author's collection)

Steam also powered many auxiliary mechanisms: pumps, capstans, and the hydraulic machinery for loading and aiming the 17in guns. The lighting of the machinery spaces was provided by electric incandescent arc lamps of the Yablochkov system.

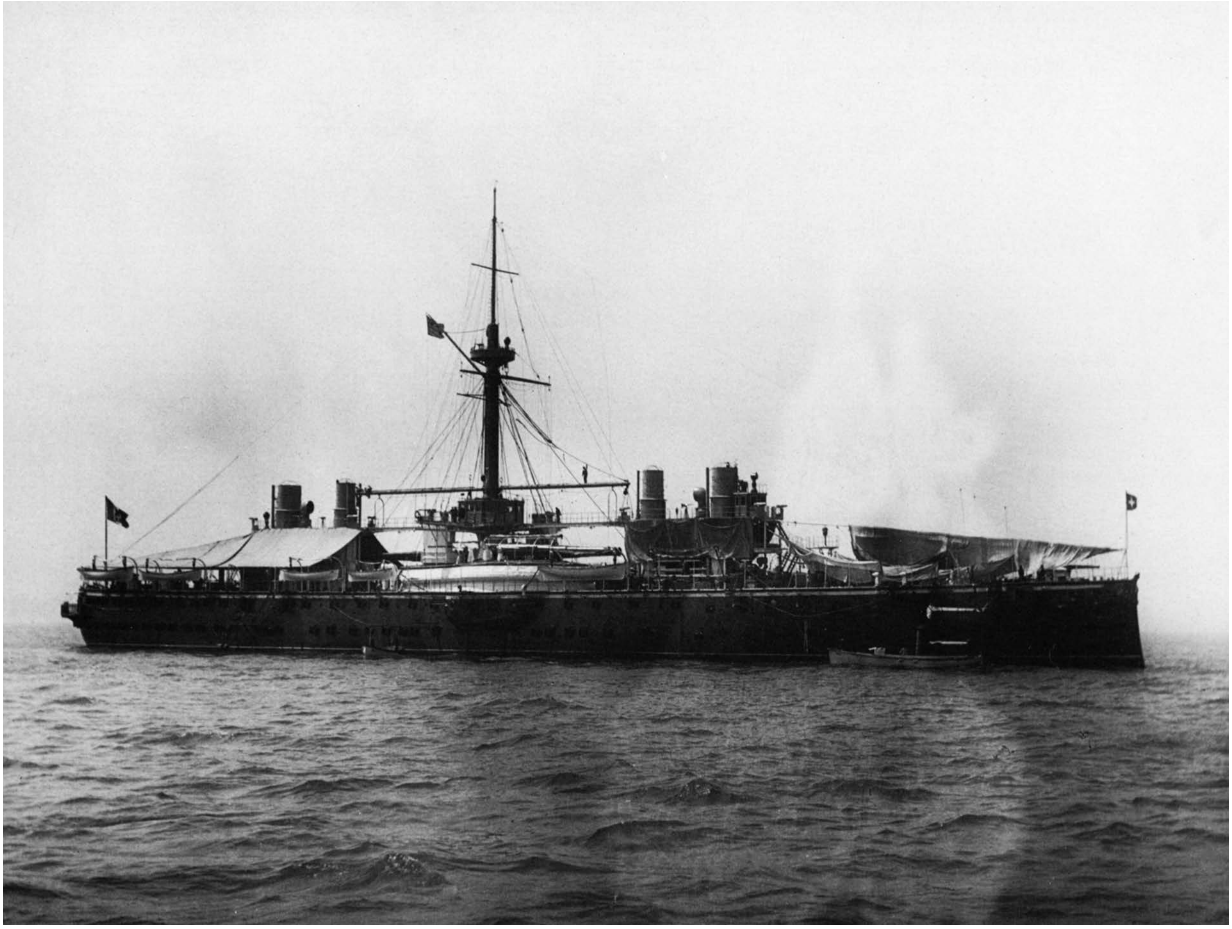
The propellers were of the standard Italian Admiralty pattern, with a diameter of 6.25m (20ft 6in) and a pitch of 6.25m (20ft 6in).

The maximum bunker capacity of the ships as designed was 3,000 tons of coal, but it seems unlikely that they ever carried this much. A modern source credits *Italia* with a capacity of 1,550 tons coal and 120 tons of oil, while giving *Lepanto*'s capacity as 1,600 tons of coal and 160 tons of oil; range is given as 5,000nm at 10 knots.[39]

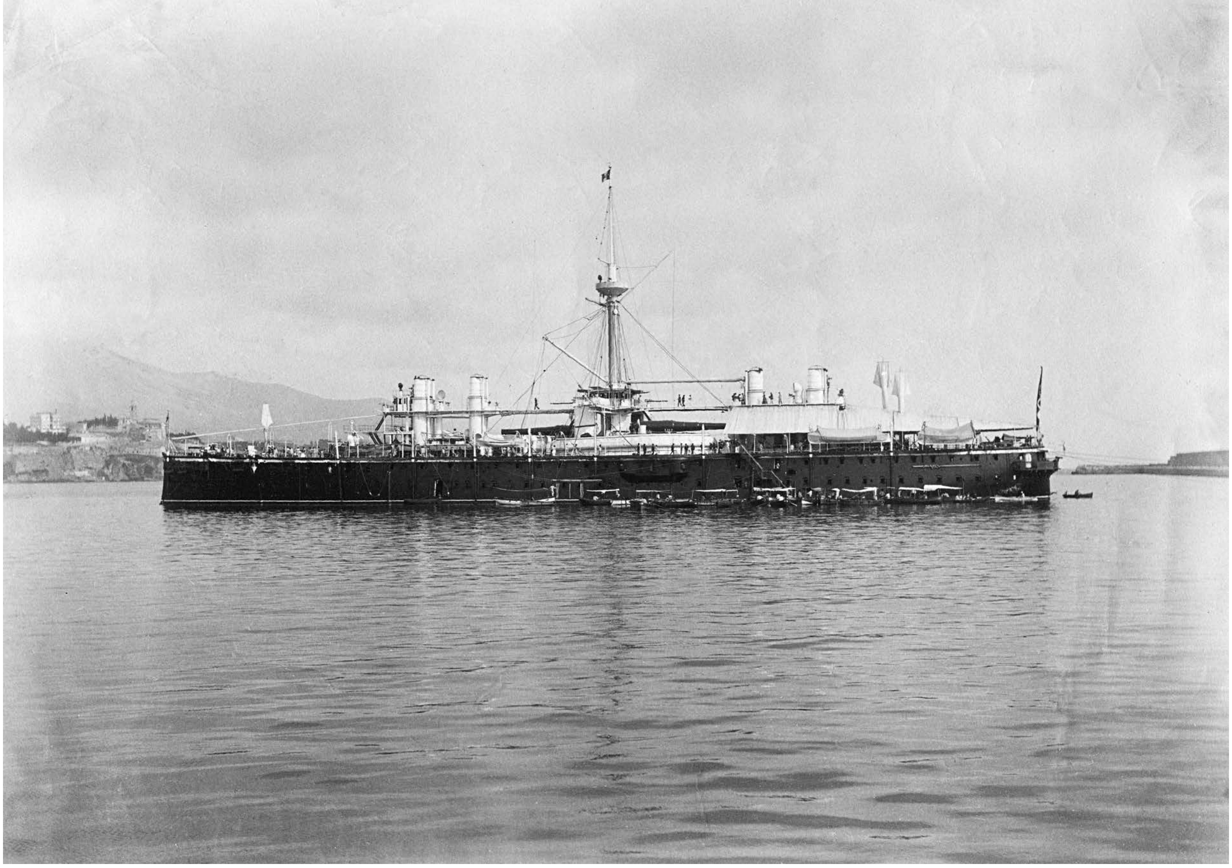
Criticism of the Design

The novel constructional features of *Italia* and *Lepanto*, in particular their huge size and impressive characteristics, inspired a great deal of interest both in Italy and abroad. In Britain Nathaniel Barnaby, the Director of Naval Construction, even developed a design for a 'much improved *Italia*', although it was rejected by the Admiralty.[40] But while naval architects often seemed favourably disposed toward these ships, naval officers were generally sceptical of their merits.

One of the leading critics was Captain CPP FitzGerald, RN, who delivered an extended critique of the type in a lecture at the Royal United Service Institution. He maintained that even the obsolescent central-battery ironclad *Hercules* (8,677 tons, launched 1868) had a good chance of defeating *Italia*.[41] He argued that, if *Italia* used her superior speed to keep beyond the range of *Hercules*' 10in guns, her chances of scoring a hit 'would be very small indeed', in part due to the slow rate of fire of her huge guns, which he estimated at one round every fifteen to twenty minutes. If on the other hand *Italia* chose to close the range, and assuming that *Italia* did not sink the *Hercules* with a lucky hit on her waterline with her first shots ('a somewhat remote chance', in FitzGerald's view), then he believed that '*Hercules* could certainly put the *Italia* in a sinking condition before she could fire another shot with those heavy guns'. The work of destruction would be done by *Hercules*' 10in (254mm) guns, firing one round per minute; their shells, exploding above *Italia*'s armoured deck, 'would very soon make short work of compartments, cork stuffing, coffer dams, or any other devices for keeping these peculiarly designed ships



Lepanto with awnings spread aft, while the awnings forward are either in the process of being spread or being taken in. (Author's collection)



Lepanto with awnings spread over the quarterdeck. (Author's collection)

afloat'. Numerous hits from the 57mm quick-firers would contribute to the riddling of the waterline, while *Hercules'* complete waterline belt, even though of wrought-iron armour, could resist such small-calibre hits. Most of the naval officers attending FitzGerald's lecture agreed with his main argument.

On the other hand, one Captain Harris took what might be termed a more positive view of the trend toward monster battleships. He acknowledged that such ships might pose a threat to the Royal Navy, but he also believed that 'if we could persuade nations like Italy, and even larger nations, to throw their whole resources and strength into monster armour-clads, when their finances will certainly not permit the construction of more than three or four of them, … we then with our more numerous vessels should have no difficulty in mobbing them in their own ports. Thus I think Signor Brin's policy of making a comparatively poor nation build very expensive and enormous ships is a good policy for England'.[42]

The French engineer P Distère also questioned the huge size of the Italian ships, writing that 'It is very possible that this [ship] will be the last, and that, instead of seeking to produce marine Colossi, a return will be made … to the dimensions of manageable ships, and to a cost such that it will not be necessary to stake our total resources on one or two elements of problematical success'.[43]

Distère had in mind ships of about 8,000 tons, and the Italian Navy's Technical Directorate thought along similar lines, for in 1878 it proposed that the next class of ships should be limited to 7,500 tons and cost about half as much as Brin's giants.[44] After much discussion, the general characteristics called for the new ships to have protection similar to that of *Italia*, with four 12in (305mm) guns mounted *en barbette*, but speed should be limited to 15 knots. The proposal was submitted to Parliament, where it was debated for four days (17–20 December 1878). In the end, the politicians decided that the new ships should not exceed 10,000 tons. The end result was the *Ruggiero di Lauria* class, designed by Giuseppe Micheli. These reverted in many ways to the *Duilio* design – armed with the same 431mm breech-loaders as *Lepanto*, but having a central citadel 431mm (17in) thick and a speed of only 16 knots.

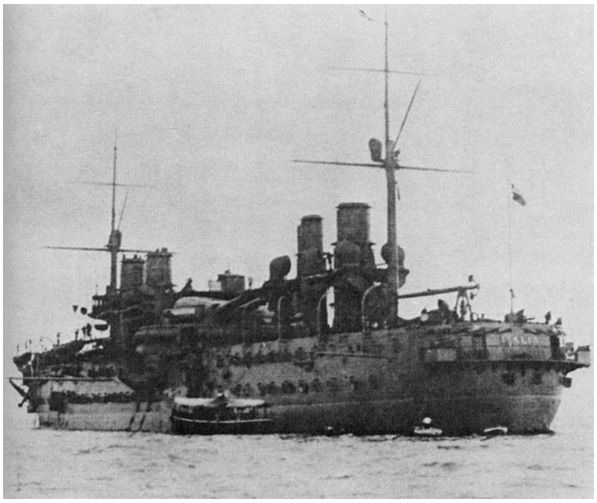
Conclusion

Italia and *Lepanto*, although revolutionary in their design, did not bring about a revolution in warship building. Their entry into service coincided with the introduction of the quick-firing gun, which sealed the fate of Brin's giants. Their protection scheme had been designed to survive infrequent hits from huge but slow-firing guns firing solid armour-piercing shot, but the new small-calibre quick-firing guns, with their hollow shells filled with explosive, promised to riddle their waterlines and destroy their cork-filled cofferdams. Brin attempted to update the basic concept of the *Italia*s in the three ships of the *Re Umberto* class, built in 1884–95; these ships were externally similar in layout to the contemporary British 'Admiral' class, but were much larger (13,600 tons normal) and faster (20 knots on trials). To protect their waterlines against light QF guns they featured a waterline belt of 100mm; otherwise, their protection was similar to that of *Italia*.[45] However, like *Italia* their timing was unfortunate, for by the time they entered service medium-calibre QF guns of 120mm to 152mm were in widespread use, rendering their thin waterline belts almost useless. At the same time, the introduction of face-hardened armour made it possible to provide more extensive side protection at a reasonable cost in weight.

Italia and *Lepanto* were built to an innovative design intended to meet the particular requirements of the Italian Navy. They were also ships of extremes: the largest, fastest and most powerful ships of their day. However, in taking the idea of armoured deck protection to its logical conclusion, they proved to be obsolescent by the time they entered service. The development of quick-firing guns rendered them vulnerable to foundering or capsize through the destruction of their unarmoured waterlines. As the Italian naval constructor Colonel G Russo aptly stated, they were 'a brilliant but unlucky conception of the mind of that great naval architect', Benedetto Brin.[46]

Careers

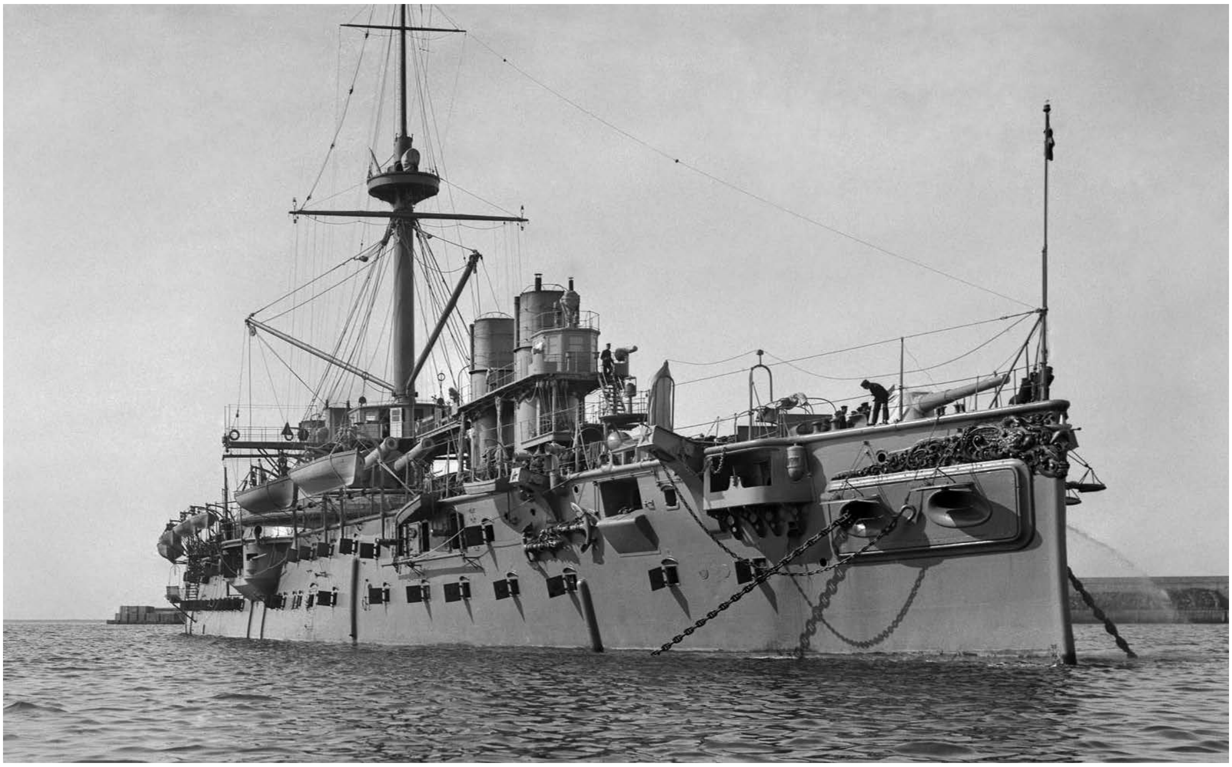
Italia ('Italy'): The ship was officially named by a royal decree dated 30 July 1876. On 10 January 1886 she hoisted the naval ensign and in April made a short training cruise, visiting Naples, Palermo, Cagliari, the Bay of Palmas, and Livorno, then returned to La Spezia. In May–June 1886 she visited Portugal, Spain and France. On 11 July she joined the *Squadra Permanente*, the Italian Navy's main operational formation, and on 1 August became the flagship of Vice Admiral Orengo. The squadron cruised in Greek and Turkish waters in October. *Italia* was in reserve at Naples and La Spezia throughout 1887. From January 1888 she returned to the *Squadra*, now under Vice Admiral Bertelli, taking part in various exercises. She was placed in reserve in November 1890. From 1891 to 1895 she saw periods of active service alternating with periods in reserve. In 1895 she became the flagship of the 3rd division of the Reserve Squadron and took part in short voyages for the training of personnel. In addition in 1896 she served as a gunnery training ship. After the formation of the *Squadra di Manovra* in July, *Italia* became flagship of the 2nd Reserve Division. She underwent a refit in 1905–06; the number of funnels was reduced from six to four and the military mast and fighting top replaced by two light pole masts fore and aft.


A poor-quality photograph of *Italia* after her 1905–06 refit, possibly while serving as a harbour defence ship at Brindisi 1915–17. She now has only four funnels, her single heavy military mast has been replaced by pole masts fore and aft, and hoods have been added over her main guns. (Wikimedia Commons)

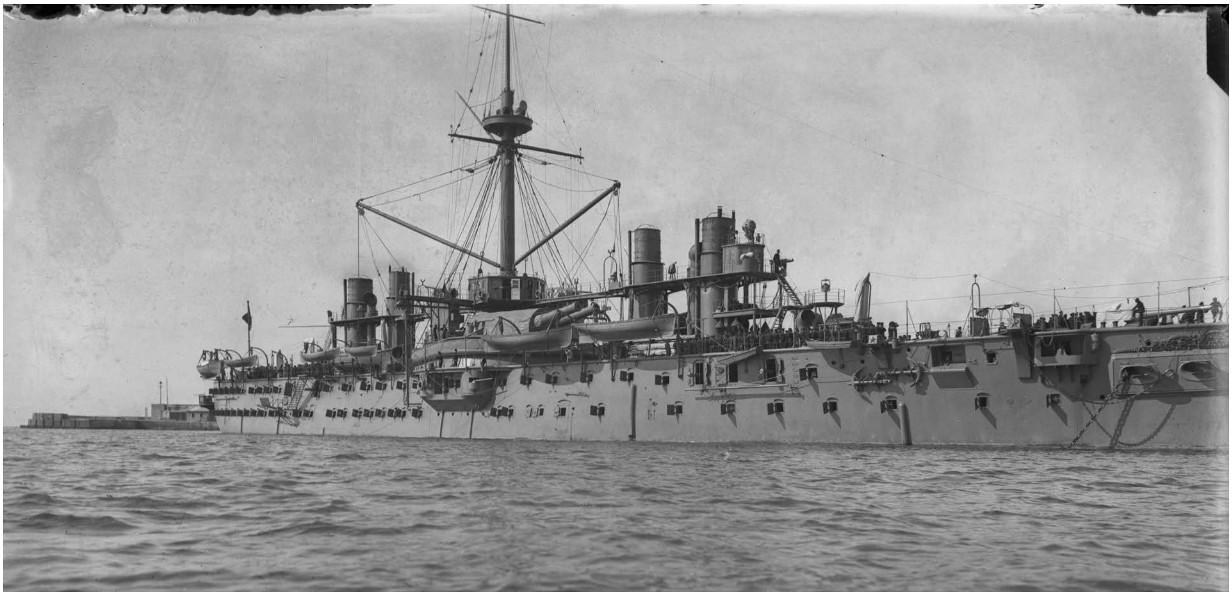
From 1909 to 1910 she served as a torpedo school ship in La Spezia, and in 1911 she was used as a floating barracks. During the Italo-Turkish War of 1911–12 plans were made to utilise *Italia* and *Lepanto* for bombarding the enemy's coasts, since there was still a large stock of 431mm shell available. However, this plan was never carried out. In December 1912 *Italia* was taken to Taranto for service as school for NCOs and mechanics. She was stricken from the fleet list by a royal decree of 4 June 1914.

On 20 April 1915 she was towed by the battleship *Ammiraglio di Saint Bon* to Brindisi for conversion into a floating battery for port defence, and on 23 May 1915 she was again enrolled in the fleet list as a first-class auxiliary. On 16 December 1917 she was transferred to La Spezia for conversion to a grain carrier, armed with two 120mm guns. The work was completed only in 1919; on 27 July she was reassigned to the State Railway Department. She returned to the Navy on 13 January 1921, was disarmed at Taranto, and finally stricken on 16 November 1921.

Lepanto (named after the Battle of Lepanto in 1571, where the combined Venetian and Spanish fleets defeated the Ottomans): She was officially named on 11 March 1877 and entered service on 16 August 1887. On 14 May 1888 she joined her sister *Italia* in the *Squadra Permanente* under Rear Admiral Bertelli. In reserve during 1891, she was recommissioned in April 1892. In 1893 she served as the flagship of the fleet commander, Vice Admiral Duke Tomaso di Savoia. On 27 April 1893 she welcomed King Umberto I and Kaiser Wilhelm I aboard. Later that year she almost rammed *Italia* during manoeuvres. She was transferred to the Reserve Squadron in February 1895. From 26 March to 20 July 1896 she served as a school for signalmen and helmsmen.



A fine photo of *Lepanto* taken after 1904, when the Italian Navy changed to an overall grey paint scheme (*grigio ferro* = 'iron grey'). The 152mm gun on her forecastle is clearly visible, as is the small sponson for a 37mm revolver cannon just above and abaft the hawse pipes. (Courtesy of Steve Given)



Another view of *Lepanto* at Genoa after 1904. Although the bow has been cut off, many details of the hull can be seen here, including the main deck sponson amidships for 57mm guns. (Courtesy of Steve Given)

She took part in the naval review at Portsmouth celebrating Queen Victoria's Diamond Jubilee in June 1897. From March 1902 to October 1910 she served as a gunnery school at La Spezia, also taking part in annual manoeuvres. She served as a floating barracks from 16 October 1910. She was stricken on 26 March 1912, but on 21 January 1913 rejoined the fleet as an auxiliary ship, serving as a naval school for apprentices and specialists at La Spezia. She was stricken on 1 January 1914 and sold for scrap on 27 March 1915.

Acknowledgements:

Sergei Vinogradov, the author of the unpublished manuscript *Bronenostsy 'Italiia' i 'Lepanto' – giganty Zheleznogo veka* [Armourclads *Italia* and *Lepanto* – Giants of the Iron Century], would like to express his deepest thanks to his long-time friend Steve McLaughlin, the translator and editor of this article. It was no easy task to compress the text to one-third of its original length while retaining its most important elements and correcting some minor points.

Stephen McLaughlin would like to express his gratitude to Enrico Cernuschi, Ed Hampshire and Norman Friedman for providing additional information that helped sort out some of the conflicting data for these ships. Steve Given generously provided superb photos of *Lepanto* from his collection (see www.flickr.com/photos/69559277@N04/). As usual, Stephen's wife Jan Torbet provided invaluable editorial assistance.

Endnotes:

[1] For Italy's overseas ambitions, see Enrico Cernuschi, Alessandro Gazzi and Michele Maria Gaetani, *Sea Power the Italian Way* (Ufficio Storico della Marina Militare, Rome 2017), 89–92.

[2] Eduardo Masdea, *L'Italia: Regia Nave di Prima Classe* (Rome 1880), 20.

[3] As reported in *l`Année Maritime*, 1877, and quoted in *Morskoi sbornik*, 1879, No 4, *neofitsial'nyi otdel*, 14, 16. Note that *Morskoi sbornik* had official [*ofitsial'nyi*] and unofficial [*neofitsial'nyi*] sections with completely separate page numbering.

[4] Brin, *La Nostra Marina Militare* (Roma, 1881), quoted by Nathaniel Barnaby, 'Battle Ships – A Forecast', *Journal of the Royal United Service Institution* (hereafter *JRUSI*), Vol XXVII, No CXIX (1883), 127–128.

[5] *Morskoi Sbornik*. 1881, No 4, *neofitsial'nyi otdel*, 34; 1883, No 4, *neofitsial'nyi otdel*, 40.

[6] *Morskoi sbornik*, 1894, No 12, *neofitsial'nyi otdel*, 14.

[7] Some sources state that only *Lepanto*'s hull was entirely made of steel, while that of *Italia* hull was steel and iron.

[8] Aldo Fraccaroli, *Italian Warships of World War One* (McMillan, London 1971), 23.

[9] *Ital'ianskii bronenosnyi flot v 1888 g* (*Glavnyi morskoi shtab* [Main Naval Staff], St Petersburg 1888), 23.

[10] William H Hovgaard, *Modern History of Warships* (originally published 1920; reprint edition Conway Maritime Press, London 1971), 60.

[11] Nabor Soliani, 'On the Steam Trials of the R[oyal] Italian Ironclad "Lepanto"', *Transactions of the Institution of Naval Architects*, Vol XXX (1889), 121.

[12] 'The Italia and Lepanto', *The Naval Annual, 1888/1889* (J Griffin and Co, Portsmouth 1889), 69.

[13] G Molli, 'L'Italia in Mare' (Roma, 1888), quoted in *Morskoi sbornik*, 1888, No 11, *neofitsial'nyi otdel*, 'Bibliografiia', 8.

[14] 'Considerazioni Sovra Taluni Appunti Fatti dal Generale Rosset Alla Nostra Artiglieria Navale', *Rivista Marittima*, 1876, No 4, 66–67.

[15] E Maitland (Superintendent, Royal Gun Factory, Woolwich), 'The Heavy Guns of 1884', *JRUSI*, Vol XXVIII, No CXXVI, 703.

[16] 'The Hundred-Ton Armstrong Breech Loading Gun', *The Engineer*, Vol LV (26 January 1883), 73–74.

[17] Maitland, *op cit*, 703–704.

[18] '100-ton Breech-Loading Guns', *The Engineer*, Vol XXXXVIII (3 October 1879), 253, 255.

[19] 'Ispytanie novogo 100-tonnogo orudiia Armstronga', *Morskoi sbornik*, No 1, *neofitsial'nyi otdel*, 43–46.

[20] Masdea, 21.

[21] Norman Friedman, *Naval Weapons of World War One: Guns, Torpedoes, Mines and ASW Weapons of All Nations* (Seaforth Publishing, Barnsley 2011), 231; Admiralty, Intelligence Department, *Italy: War Vessels and Torpedo Boats (Revised)*, 1897 (No 486, October 1897), 77.

[22] *Ital'ianskii bronenosnyi flot*, 25; *Italy: War Vessels and Torpedo Boats*, 1897, 77, 79.

[23] *Ital'ianskii bronenosnyi flot*, 24; *Italy: War Vessels and Torpedo Boats*, 1897, 77.

[24] Franco Bargoni, *Corazzate italiane classi Duilio, Italia, Ruggero di Lauria (1880–1892)* (Rome: Ateneo e Bizzarri, 1977), 26–27.

[25] *Ital'ianskii bronenosnyi flot*, 28.

[26] *Italy:War Vessels and Torpedo Boats*, 1897, 77, 79.

[27] Hovgaard, *op cit*, 58–59.

[28] *The Naval Annual, 1886*, 302–303.

[29] The Conclusion of the Spezia Plate Trials', *The Engineer*, Vol LIX (27 February 1885), 161–162.

[30] Hovgaard, *op cit*, 58: Hovgaard states that the redoubt's armour was 17in (432mm) thick.

[31] *Ital'ianskii bronenosnyi flot*, 23.

[32] In *Italy:War Vessels and Torpedo Boats*, 1897, 77, 79, it is stated that the supply tube was 15.75–19in (400–480mm) thick, while Hovgaard, 58, states it was 18in (457mm).

[33] The thickness for the conning tower given here is based on *Morskoi sbornik*, 1886, No 8, *neofitsial'nyi otdel*, 62, quoting an article from *Journal de la Marine* (*Le Yacht*) about the armour made by Schneider for *Lepanto*. In *Italy: War Vessels and Torpedo Boats*, 1897, 77, 79, it is stated that the tower armour was 15.75in (400mm), while Fraccaroli, *Italian Warships of World War One*, 23, says it was 100mm.

[34] Masdea, *op cit*, 27.

[35] *Journal de la Marine (Le Yacht)*, 1886, No 424 (24 April 1886), 175.

[36] *Ital'ianskii bronenosnyi flot*, 26.

[37] Edgar C Smith, *A Short History of Marine Engineering* (Cambridge University Press, 1938), 260–261.

[38] Soliani, *op cit*, 120.

[39] Bargoni, *op cit*, 26.

[40] Oscar Parkes, *British Battleships: 'Warrior' 1860 to 'Vanguard' 1950: A History of Design, Construction and Armament* (Seeley Service & Co, London 1957), 283.

[41] CCP FitzGerald, 'Side Armour Versus Armoured Decks, From A Naval Point of View', *JRUSI*, Vol XXIX, No CIXVIII (1885), 68–70.

[42] Barnaby, *op cit*, 143.

[43] P Distère, quoted in 'Estimates for the Italian Navy for 1878, and Account of the New Ironclad "ITALIA", Building at Castellamare', *JRUSI*, Vol XXII, No XCIV (1879), 262.

[44] 'Sh' (pseudonym), 'Vopros o postroike novykh bronenostsev v Italiia', *Morskoi sbornik*, 1881, No 4, *neofitsial'nyi otdel*, 5.

[45] *Conway's All the World's Fighting Ships 1860–1905* (Conway Maritime Press, London 1979), 342.

[46] G Russo, 'Fifty Years' Progress of Shipbuilding in Italy', *Transactions of the Institution of Naval Architects*, Vol LIII (1911), 263.

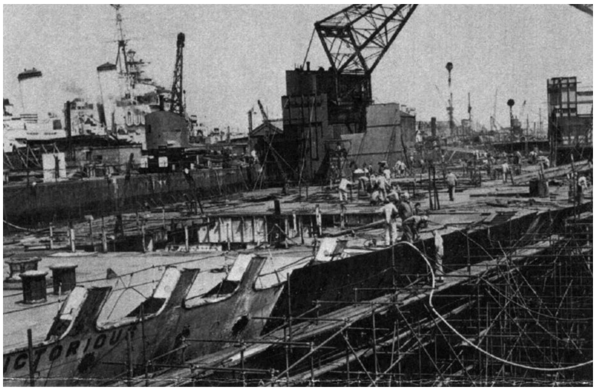
THE RECONSTRUCTION OF HMS *VICTORIOUS*

David Hobbs gives a detailed account of the reconstruction of HMS *Victorious* during the 1950s and outlines her seminal role in the development of the modern aircraft carrier in the Royal Navy.

By 1945 the six armoured carriers of the *Illustrious* class were clearly not going to be capable of operating the heavy jet and turbo-prop strike fighters that were under development. Since none of them was more than five years old, the Admiralty Board ordered a study to be carried out by a group led by the Assistant Chief of the Naval Staff (Air) which was tasked with evaluating the possibility of modernising these ships. It reported that such work could only be justified if it brought the ships up to the most advanced standard, capable of operating the next projected generation of naval aircraft, of which fighters would be the most demanding. Carriers modernised in this way could, ACNS (Air) believed, offer a further twenty years' service for half the cost of new construction, and the Board accepted this view.

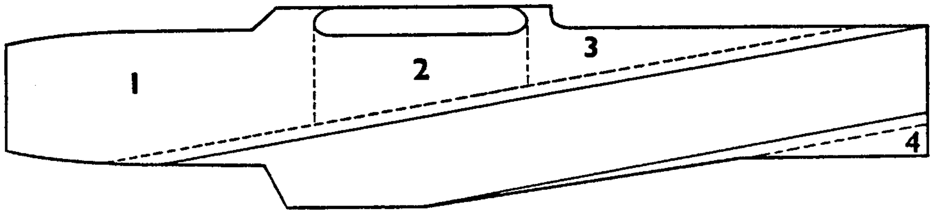
In February 1948 the Director of Naval Construction (DNC) was instructed to prepare designs for the modernisation of a fleet carrier to operate aircraft up to a maximum weight of 30,000lb (13,600kg) with hangar height increased to the new standard of 17 feet 6 inches (5.33m). The single hydraulic catapult was to be replaced by two of the projected steam catapults and the ship was also to be fitted with new arrester gear, new emergency barriers capable of stopping jet fighters safely, greatly increased aviation fuel stowage and improved workshops. HMS *Formidable* was originally intended to be the first taken in hand, to be followed by at least three other ships of the *Illustrious* class. However, a survey of her hull found her to be in poor material state, having been laid up without maintenance for some years. HMS *Victorious,* in commission as a training ship, was found to be in much better condition and it was therefore decided to modernise her first. She was taken in hand in Portsmouth Dockyard on 10 October 1950.

The original modernisation design, scheduled to be completed in mid-1954, was comparatively straightforward, but it ran into an era of considerable change in aircraft design and, consequently, in aircraft carrier operating technology and methods. When work started to dismantle the old hull down to hangar deck level, the angled deck had not been thought of, there was no idea of fitting a three-dimensional radar as large and sophisticated as Type 984 and neither the comprehensive display system, CDS, nor its associated digital plot transmission (DPT) system had advanced beyond the staff requirement stage. The characteristics of the generation of aircraft that would enter service in the late 1950s were by no means clear, nor could their requirements for sophisticated support be foreseen and factored into the design. Airborne radars and other avionics had made little impact on the 1950 design, nor had the need to store and prepare the guided missiles and nuclear weapons with which the new aircraft would be armed. The work carried out between 1950 and 1958 to build a new *Victorious* should, therefore, be thought of as a series of modernisations that took place within a prolonged, overall building process. Some of them required work that had already been completed to be dismantled before the new equipment and structure could be fitted.


Victorious in 'D' Lock in Portsmouth Dockyard in early 1951; she has been dismantled down to the level of the hangar deck. (Author's collection)

Flight Deck

In 1950 the new flight deck design was conventional and aligned with the ship's centreline. The landing area aft was still to be separated from the parking area forward, known as Fly 1, by three collapsible barriers but, with jet fighter cockpits in the nose of their aircraft, barrier entry had become more dangerous for pilots than it had been in the piston-engined era and was also likely to cause significant damage to the aircraft. Higher landing speeds also posed a problem as the landing area had to be extended farther forward in order to accommodate sufficient arrester wires to maximise the probability of an arrester hook catching one and allow for their extended



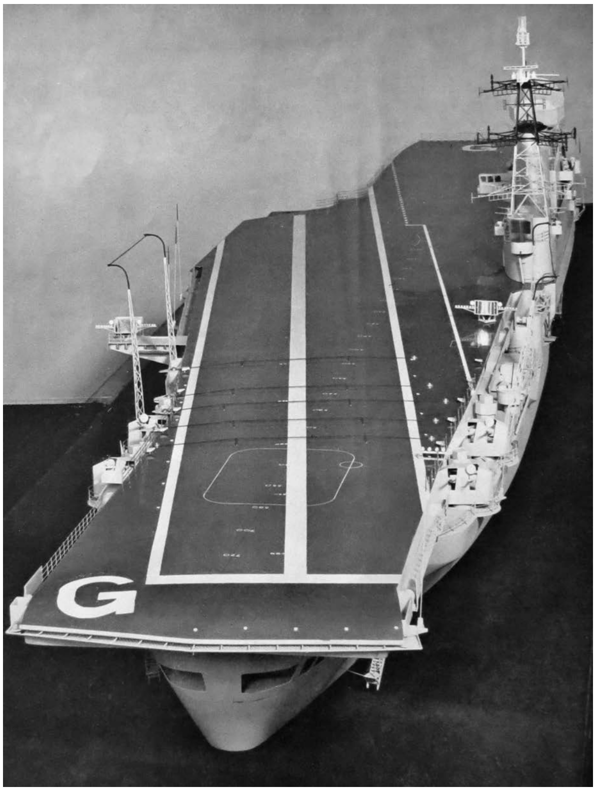
The flight deck parking areas, designated Fly 1–4. (Author's collection)

pull-out, even in adverse conditions. In contrast, the US Navy had a large number of carriers which had longer flight decks; the same problem was recognised, therefore, but not addressed with the same urgency as in the RN. It is also clear that in the late 1940s, USN attention was focused more on plans to operate large bombers armed with nuclear weapons from its carriers than on specific details of how best to operate every ship to best advantage with a wide variety of aircraft types.[1] The RN had few carriers potentially capable of operating the generation of strike fighters envisaged for the mid- to late-1950s without extensive modification, so the problem of deck space was viewed with significantly greater urgency.

By the early 1950s the RN carrier air groups had begun to re-equip with second-generation jet fighters such as the Hawker Sea Hawk, which had a maximum loaded weight of 16,200lb (7,350kg) and landed on at about 100 knots (185k/h), the exact speed depending on weight at the time of recovery. They needed two-thirds of the axial deck clear aft of the aftermost barrier for their arrested landings and space forward of the forward barrier for it to extend into if it was engaged. This severely limited the amount of room available in Fly 1 to park aircraft, and therefore limited the size of a deck-load strike force to the number of aircraft that could be landed-on in a single recovery rather than the number that could be ranged aft for take-off. The next generation of aircraft, already in development, were known to have even higher landing speeds which would reduce Fly 1 still further. Even *Ark Royal* and the 1943 light fleet carriers nearing completion in the early 1950s were basically pre-1945 designs that would require significant reconstruction to keep them viable in the new fast-jet era. It seemed that carriers might be forced to return to the clear-deck method of recovery used in the 1920s, and with funding for new construction ruled out by successive governments the RN was forced to seek a radical solution if its carrier force was to remain viable.

Angled Deck

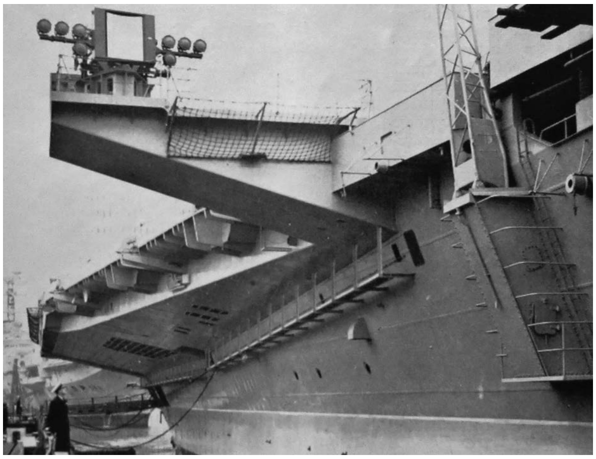
That solution was provided by Captain DRF Campbell RN, a wartime fighter pilot who was the Deputy Chief Naval Representative at the Ministry of Supply in 1952. He drew his inspiration from recent experiments with flexible, or 'rubber' decks which had been intended to allow aircraft without undercarriages to make soft landings on aircraft carriers. Arrested landing on the flexible deck itself had proved practical but the experiment failed because movement of the aircraft after they had come to rest proved both time-consuming and difficult since they had to be lifted by crane onto wheeled trolleys. Schemes to offset the flexible landing mat to make it easier for aircraft to be pulled off gave Campbell the idea of offsetting the whole landing area radially from the ship's centreline once the flexible deck concept had been discarded. It was immediately clear to him that a number of benefits would follow, since even a small angle brought the forward end of the landing area to the edge of the flight deck at a point well aft of the bows, effectively creating the elongated space needed for arrested landings. Of equal importance, the area to starboard of the landing area could be used as an enlarged parking space which extended the original Fly 1 into a new clear space, Fly 2, to port of the island structure. The sum of the lengths of the usable landing and parking areas was in fact greater than the length of the original axial flight deck. The angled deck also gave pilots a clear deck ahead of them if they missed all the arrester wires, an event



A large model used by the Admiralty in 1957 to show what the reconstructed *Victorious* would look like. Note that it has five arrester wires whereas the ship was actually completed with four. The early deck recognition letter G was replaced with the more appropriate V by 1958. (Author's collection) subsequently known as a 'bolter'. There was no longer a need for barriers to separate aircraft landing on from parked aircraft, and pilots who 'bolted' could open the throttle and climb away for another circuit to land. Discarding the barriers meant that the number of wires could be reduced, and those that were retained could be positioned farther forward, closer to the centre of the ship's pitching moment. The new jet technique of landing with power on perfectly matched Campbell's new concept which was known at first as the 'skew deck' in the RN and 'canted deck' in the US Navy. Full details were given to the USN at every stage under the Mutual Defense Assistance Program (MDAP), and both navies subsequently adopted the term 'angled deck' which is still used today. Since every carrier had its island on the starboard side, the sponson needed to support the outer extremity of the angled deck was placed on the port side amidships.

The idea was validated by painting an angled deck on the flight deck of the light fleet carrier HMS *Triumph* in January 1952. It extended from the starboard quarter to a point on the port deck edge just forward of the island; although angled at only 3 degrees off the ship's centreline, it still allowed a significant parking area to starboard. The arrester wires were removed as they were aligned with the axial deck and could not easily be realigned with the angled deck for the trial. In February 1952 a variety of different RN aircraft types made low approaches to HMS *Triumph*'s angled deck monitored by a batsman. No touch-and-go roller landings were permitted, however, because the temporary landing area was not considered long enough for aircraft to fly away safely after impacting the deck. Pilots from the USN and RCN also took part in the trials, which proved to be an outstanding success. After a similar USN trial with an angle painted on the deck of an *Essex* class carrier, work was authorised to modify the USS *Antietam* of the same class with a full 10-degree angled deck supported by a sponson on the port side. The arrester wires were realigned to lie across the new landing area, and after work on *Antietam* was completed in late 1952 she carried out extensive deck landing trials in early 1953. In the autumn she visited the UK and a number of British aircraft landed on her deck.

The success of the early trials led the Admiralty to give instructions that *Ark Royal, Bulwark* and *Albion* should be completed with interim 5-degree angled decks with their arrester wires reduced in number and re-aligned. *Centaur* was too far advanced but was to be retro-fitted with an interim deck as soon as possible after her completion in 1953. The interim angle was specified because it required only minimal structural changes to hulls that were already complete with no need for large sponsons. However, the Admiralty decided that the full modification was worth making in the still-incomplete *Victorious*, and instructions were given in 1953 to modify the design to take an 8.75-degree angled deck, delete the barriers and reduce the number of arrester wires from eight to four aligned with the new deck. This meant that a sponson which weighed 500 tons had to be fitted to the port side, displacing some of the designed close-range armament. This had the effect of making the hull sit lower in the water, but offered the benefit of adding significant internal volume to the new hull, space that provided accommodation and boiler room air intakes in what would otherwise have been a very cramped ship.



The angled deck sponson with its conspicuous boiler intake openings and mirror landing aid seen shortly after completion. Note the welded construction of the upper hull. (Author's collection)

Aircraft Lifts

As completed in 1958 *Victorious* had a forward lift 58 feet (17.68m) long by 40 feet (12.2m) wide and an after lift 54 feet (16.46m) long by 34 feet (10.36m) wide, both on the hull centreline and capable of lifting aircraft weighing up to 42,000lb (19,050kg). Her original lifts were only 45 feet (13.72m) long by 22 feet (6.71m) wide and limited to aircraft weighing only 14,000lb (6,350kg). Consideration had been given, early in the redesign process, to fitting a side lift onto the port side of the original straight flight deck forward of the barriers so that unserviceable aircraft could be struck down into the hangar while serviceable aircraft taxied forward into Fly 1, as a way of increasing the size of the deck-load strike that could be landed on in a single recovery. Extra weight, including the angled deck sponson, made the ship sit lower in the water, however, and it was calculated that at deep load the hangar deck would only be fourteen feet above the waterline. This meant that the lift platform's supporting structure might be hit by waves when lowered in any but the calmest sea conditions and the idea was rejected.

Steam Catapults

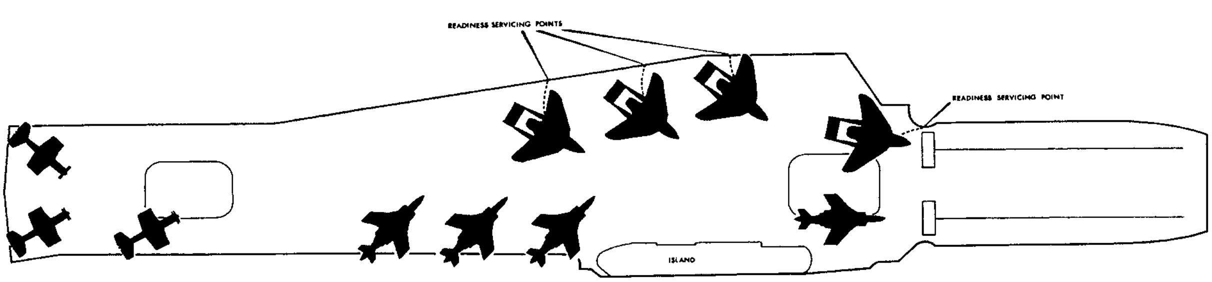
By 1950 hydraulic catapults fitted in British aircraft carriers had reached the design limit of wires and pulleys extended by a piston. The BH5 units originally fitted in

HMS *Eagle* in 1951 were capable of launching aircraft weighing up to 30,000lb (13,600kg) at an end speed of 85 knots (155k/h) relative to the deck and imposed a loading of 5g on airframe and aircrew. This was within the tolerance of both when applied progressively, but maximum acceleration was reached after only one third of its short travel, which was 30 feet (9.14m) in the case of HMS *Eagle*. Commander CC Mitchell RNVR had proposed the use of a slotted cylinder catapult powered by steam from the carrier's boilers in the late 1930s, but there had been no need for such a powerful system at the time and it was not taken forward. In 1945 Mitchell found that the Germans had used technology similar to his own proposal for launching V1 cruise missiles, and he acquired component parts through the British Intelligence Operational Survey Team to hasten a demonstration of his concept, a catapult in which rams were driven along parallel cylinders by steam pressure. They were linked by a cradle which ensured that they ran together and provided the structure on which the shuttle was fixed. This ran along a slot in the flight deck pulling a wire strop with ends looped over hooks on the aircraft being launched. Strops fell clear into the sea after every launch and so had to be available in large numbers. Rubber seals ran along the top of the catapult cylinders; these were forced open by devices on the leading edge of the cradle and closed by others at its rear after it had passed so that steam pressure would not be lost. High pressure steam was provided from the ship's boilers and stored in large accumulators at up to 4,000psi. The pressure applied to the rams could be adjusted to give the desired end speed relative to the deck for any aircraft type and weight after taking into account the wind over the deck generated by ship speed and accurately measured natural wind. Steam catapult acceleration was smooth, maximum acceleration being reached after the shuttle had travelled two thirds of the length of the cylinders, and its energy potential was sufficient to match the increasing weight of new naval aircraft designs.

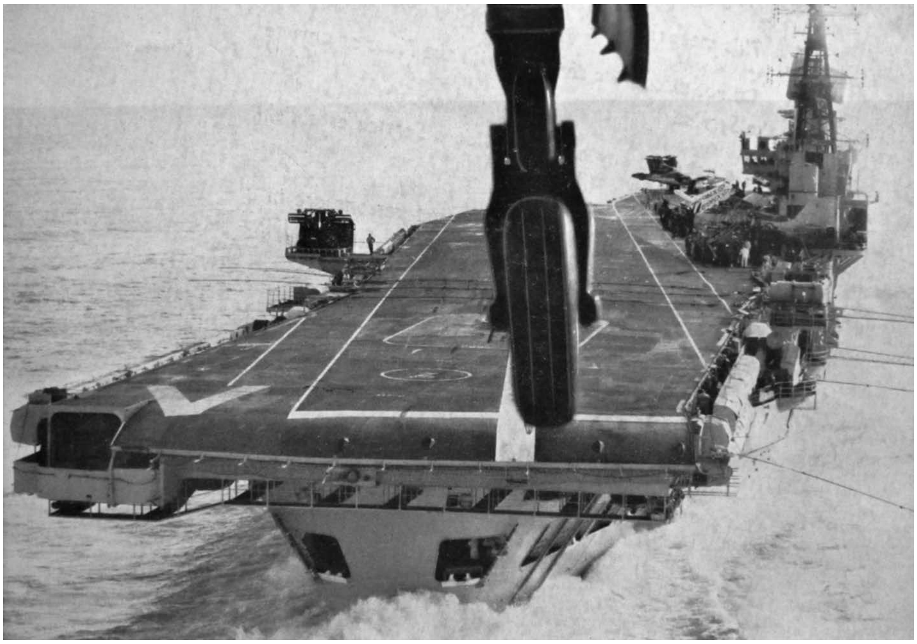
On being demobilised from the RNVR, Mitchell joined Brown Brothers, who were given an Admiralty contract to design, develop and manufacture the steam catapult. A prototype, designated BXS 1, was constructed in a new structure on the upper deck of the former maintenance carrier HMS *Perseus* in Rosyth Dockyard in early 1951. At that time the hull of *Victorious* was being stripped down to 4 deck level in 'D' Lock in Portsmouth Dockyard and, although she was intended to have steam catapults, it is clear that their design was not yet finalised and some design flexibility would have to be exercised within the forward part of the hull to incorporate them. She was eventually to have two BS4 units installed, each 145 feet (44.2m) long, running parallel in Fly 1 forward of the forward lift. Both were capable of launching a 50,000lb (22,680kg) aircraft at up to 97 knots (177k/h) end speed relative to the deck.

Mirror Landing Aid

In the era of piston-engined aircraft, pilots were given advice to achieve the ideal glide-slope, line up accurately and cut their throttles at just the right point to put their arrester hooks into the wires by means of signals from a batsman standing on a platform on the port after end of the axial flight deck.[2] Each landing was therefore a team affair, with responsibility shared between pilot and batsman. As closing speeds increased, doubling in the decade between 1945 and 1955, the pilot/batsman combination was found to have increasingly severe limitations. A large number of arrester wires had to be retained to offer the largest 'window' for arrester hooks to be engaged, increasing the size of the landing area and reducing the size of the parking area as described above. The solution to this problem was conceived by another RN officer, Commander HCN Goodhart RN, who was serving at the time as Captain Campbell's assistant. It was developed into an operational system by the Royal Aircraft Establishment and comprised a gyro-stabilised mirror, situated to port of the angled deck, in which the pilot saw the reflection of lights angled to indicate the ideal glide-slope. His movement above or below the ideal was indicated instantly by the movement up or down of the reflected light relative to a line of green datum lights situated on either side of the 'deck landing mirror sight', as the equipment became known. The reflected ball of light soon became known as the 'meatball' or more simply 'the ball' in both the RN and the USN, which both adopted the system. The pilot was thus given a continuous and proportional indication of his divergence from the ideal approach path, allowing him to take prompt corrective action. The 'meatball' and datum lights could be seen from farther away than the batsman, and pilots



A typical launch range showing the distinctive twin-boom de Havilland Sea Vixen fighter aircraft, Blackburn Buccaneer strike aircraft and, right aft, Fairey Gannet AEW aircraft. (Author's collection)



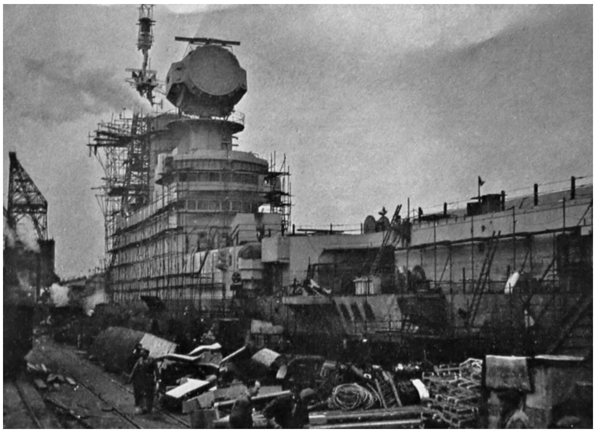
Victorious' angled deck seen from a camera mounted in the nose-wheel bay of a Buccaneer. The ball on the projector landing aid, which replaced the mirror landing aid in 1963, appears slightly low because the camera is below the pilot's eye line. To the pilot, this would appear to be a perfect approach. Note that only three arrester wires are rigged; the deck pennant of the fourth, having been found unserviceable, has been removed and will be replaced after the recovery is complete. (Author's collection)

could even begin to make small corrections as they turned onto final approach, thereby lessening the potential need for large corrections later.

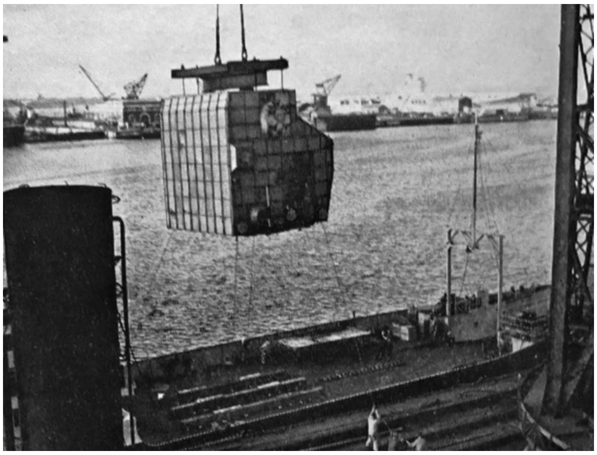
From the naval constructor's perspective, the mirror sight was awkward to install since it had to be mounted on the port side at flight deck level but well clear of the deck edge so that it would not snag the wingtip of a large aircraft such as the Fairey Gannet if it landed to port of the angled deck centreline. The space between the lights and the mirror had to be clear of any obstruction, and care had to be taken that the lights did not illuminate the side of the ship, thus giving away its position

A Supermarine Scimitar of 803 Naval Air Squadron landing on *Victorious* in January 1959. (Author's collection) during operations. A mock-up was fitted in the trials carrier HMS *Illustrious* in October 1952.[3] Its reflecting surface was made convex to diffuse the reflected light over a wide horizontal angle. It comprised a sheet of polished steel secured to a wooden backboard, and the datum bars were simple linear mirrors, also made of polished steel, angled at 45 degrees to reflect the sky. While crudely made, it showed sufficient promise to warrant the construction of a more sophisticated prototype which had an aluminium-faced mirror and datum bars comprising aft-facing green lights. It was fitted with gyroscopic stabilisation to cancel the effect of ship motion and was installed on HMS *Indomitable* in June 1953, 200 feet forward of the after round-down. Trial landings by operational aircraft were then carried out, witnessed by RN, RCN, USN and US Marine Corps observers and flown by both British and American pilots. The sight confirmed all that had been hoped for: approaches to the deck were accurate, easily interpreted and likely to be possible in all flyable conditions of light and weather. The exact point at which the hook would hit the deck could be adjusted simply by changing the tilt of the mirror slightly. Together with the angled deck, the mirror introduced a new era of deck landing that was both more efficient and safer than earlier techniques.

After the *Indomitable* trial, the sight was made adjustable vertically to take into account the different 'hook to pilot's eye' distances of different naval aircraft, and the reflecting surface was reversed to become a concave parabola which focused the beams from the source lights better but still gave good horizontal beam width. The number of source lights was increased from two to four with two different power supplies. Thus modified, this mirror was installed on HMS *Illustrious* for further trials in November 1953, which were completely successful. The sight was immediately accepted for operational use on all angled deck carriers in both the RN and USN, and the first carrier to be completed with an angled deck – albeit an interim one of only 5 degrees – and a mirror landing aid was HMS *Albion* in May 1954. She was followed by the modernised USS *Shangri-La*, the first ship in any navy to be modernised with steam catapults, angled deck and mirror landing aid. Three weeks later, on 25 February 1955, HMS *Ark Royal* (IV) became the first aircraft carrier to be completed with the three developments installed during build rather than retro-fitted after completion. Before the end of 1955 two other carriers, the USS *Forrestal* and HMAS *Melbourne*, were completed with the new technologies built into them.



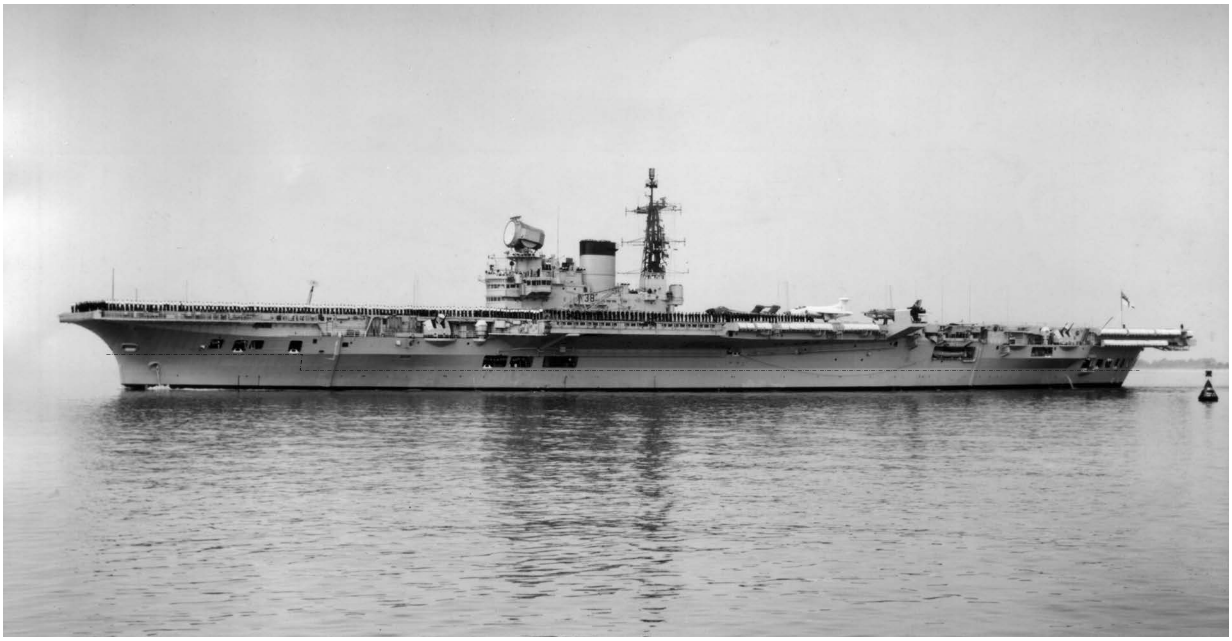
Raising steam for the first time during 1957. Note the distinctive antenna for the Type 984 three-dimensional radar atop the island and the piles of discarded material stripped out of the original lower hull lying on the jetty. (Author's collection)



Number 5 boiler is hoisted on board prior to fitting. (Author's collection)

By 1955 it had become clear that the cost of *Victorious*' reconstruction would be far greater than estimated, and plans to modernise other ships of her class were abandoned. *Ark Royal, Bulwark*, *Albion* and *Centaur* had been completed with interim angled decks and mirror landing aids but only the former had steam catapults. None of them would be able to operate Scimitars and Sea Vixens without significant modification, and so by 1955 the Admiralty recognised that *Victorious* represented the only way of obtaining a new carrier that incorporated all the new technologies built

Victorious running her full power trial in 1958, shortly after completion. (Author's collection)



Victorious sailing from Portsmouth on 29 July 1963 for flying trials with Sea Vixen, Buccaneer and Scimitar aircraft on deck. Everything above the dotted line was a new ship and new boilers, magazines, generators, fuel stowage and stores complexes were built into the original hull space below it. (Author's collection)

into a carrier in the most effective way. Her reconstruction had become vital to the modernisation of the postwar RN.

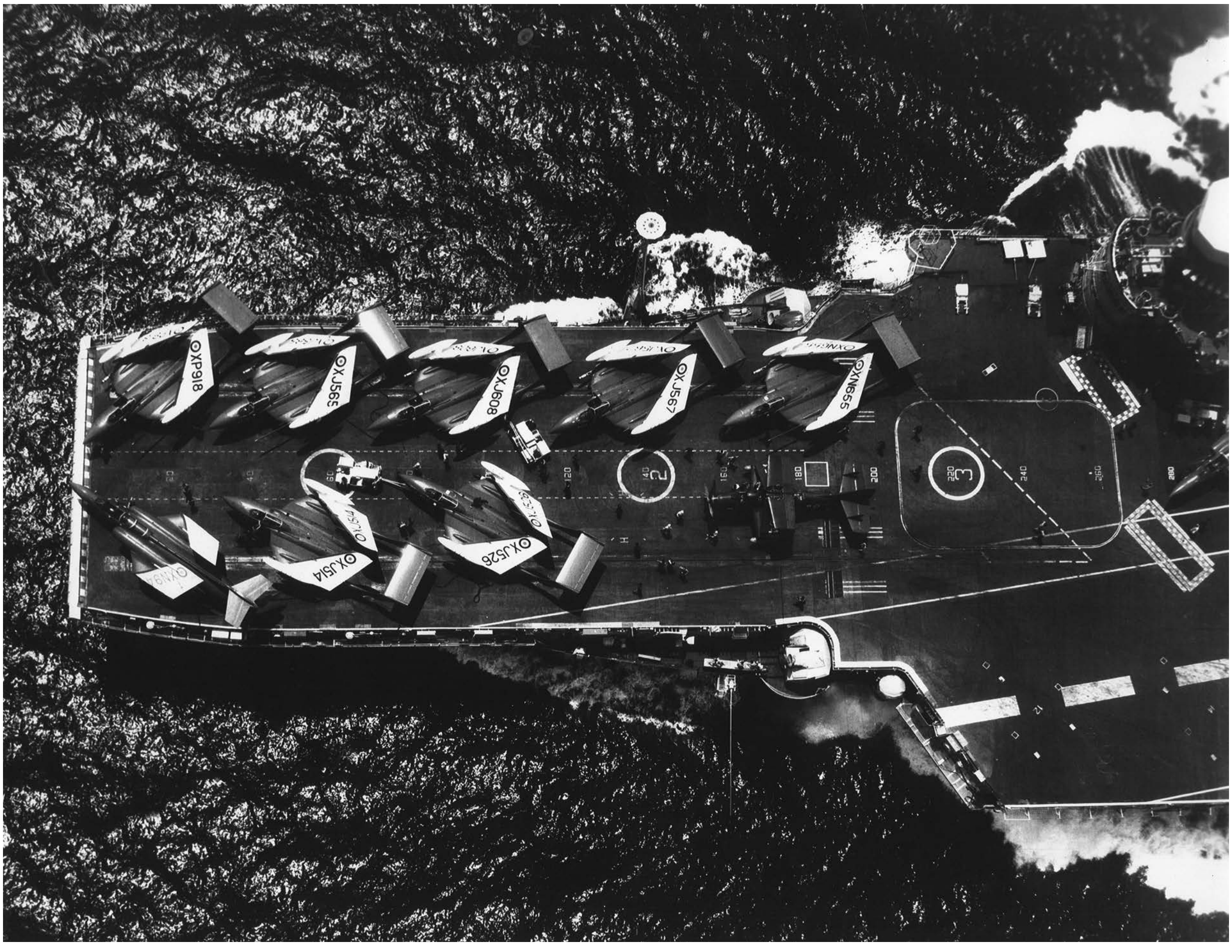
Jet Blast Deflectors

Other technologies also needed to be incorporated into *Victorious* to make her fully effective. The blast of propeller-driven aircraft had always made the deck aft of them a dangerous place for aircraft handlers and mechanics after engine start-up, but jet fighters made the situation worse. A Hawker Sea Hawk's single Rolls Royce Nene 103 jet engine, for instance, produced 5,400lb (2,450kg) of thrust at full power. This had been manageable, but the Supermarine Scimitar's two Rolls Royce Avon 202 turbojets produced 22,500lb (10,200kg) of thrust at full power and the personnel and aircraft aft of the catapults had to be protected from it. Jet blast deflectors (JBDs) had been fitted to the USN's *Essex* class carriers as they were modernised, and a British version was designed specifically for *Victorious*. Two were fitted, one aft of each of the two steam catapults, comprising large steel plates angled to deflect blast when they were raised by hydraulic jacks. They were designed to lay flat on the deck when not in use and their controls were in the catapult control position between the catapult tracks, known as the 'howdah', which was itself lowered flush with the deck when not in use. Rather than weaken the armoured flight deck by cutting into it, the JBDs were mounted on top of it, with their hydraulic jacks and pipe-work underneath. Bevelled plates were, therefore, welded around their edges to enable aircraft to taxi over them smoothly.

Aviation Fuel Stowage

The reconstruction of *Victorious* included the installation of significantly enlarged aviation fuel stowage arrangements. The original hull had a capacity of only 50,660 gallons (230,300 litres) of avgas which, because of its low flash-point, had to be stowed in cylindrical tanks built into compartments that could be flooded as a safety measure and were located low in the hull behind armour and the 'sandwich' protective system. This precaution prevented the loss of any British-built aircraft carrier to fire or petrol vapour explosion during the Second World War, but limited the quantity that could be carried. Greater capacity was needed to enable *Victorious* to operate jet fighters effectively because they used considerably more fuel per sortie than piston-engined aircraft. Fortunately, the new jets burned aviation catoline spirit, known as avcat, which had a higher flash point than avgas and could be stowed safely in bulk. Large spaces fore and aft of the machinery but still inside the protection system were built to contain avcat, the forward one containing 285,000 gallons (1,295,610 litres). It was so big that internal bulkheads, penetrated by small holes that allowed the liquid to move within in it a controlled way, had to be fitted to provide rigidity and prevent the formation of a large free surface that might adversely affect the ship's stability as the fuel 'sloshed' from side to side with ship movement.

Victorious' designed fuel stowage was complicated in 1956, however, by the Admiralty Board decision to replace the turbo-prop Fairey Gannet AS 4 anti-submarine aircraft, which used avcat, with Westland Whirlwind piston-engined helicopters, which used avgas, after 1957. By then it was also clear that the



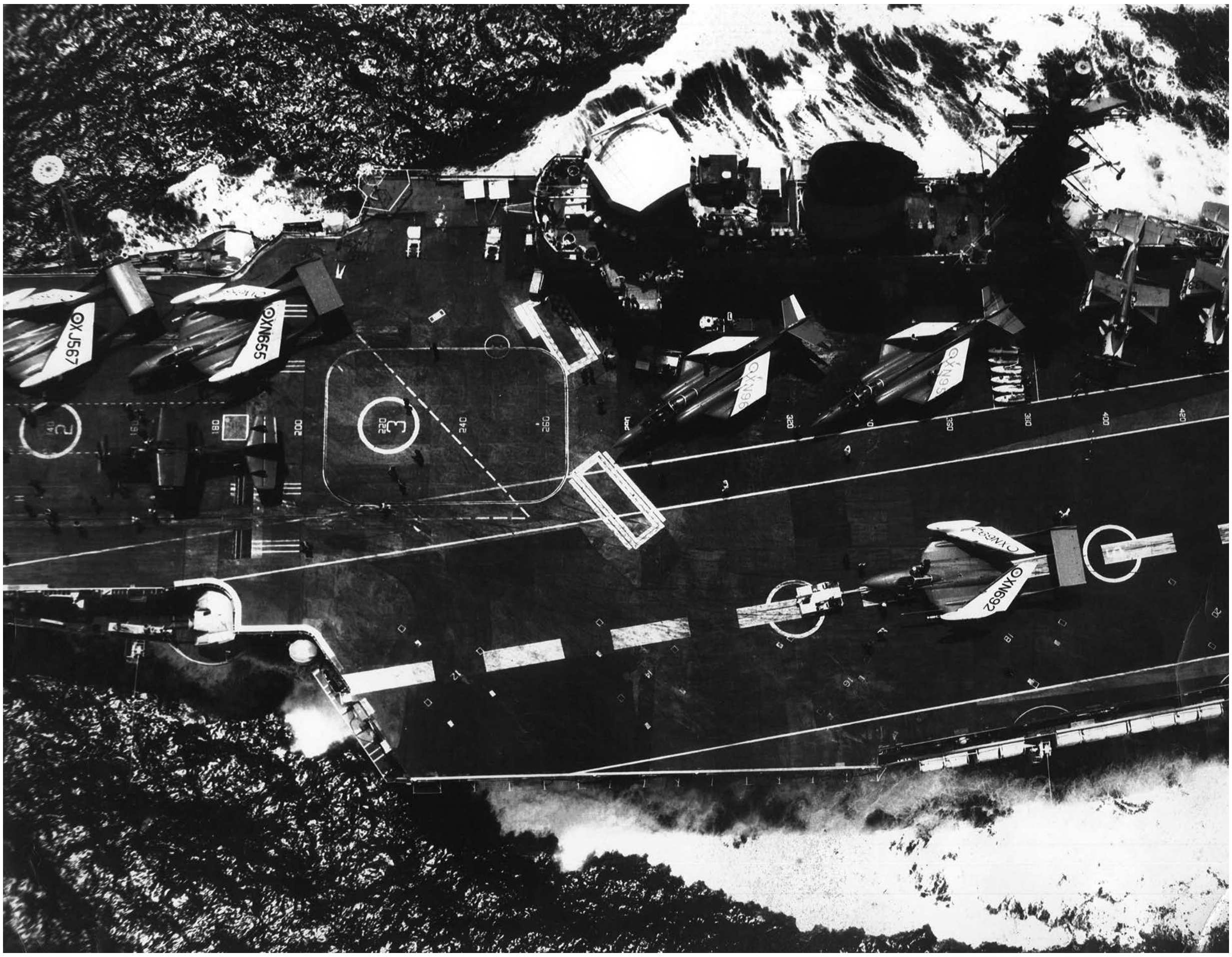
These four overhead photographs were taken by an F95 camera which formed part of a reconnaissance pod fitted in the bomb bay of a Buccaneer. They show *Victorious* as she appeared after her 1962/63 refit but before November 1965 when Sea Vixen FAW 2s replaced the FAW 1, probably in 1964 while she was serving with the Far East Fleet. (All are Crown Copyright, Admiralty, Public Sector Information licensed under the Open Government Licence v1.0 in the UK).

Above: Fly 1 with seven Sea Vixen FAW 1, a single Buccaneer S 1 and a Gannet COD 4 parked clear to starboard of the wingtip safety line. Circles show numbered helicopter spots 1 to 3 with the latter on the forward lift platform. Marshalled into Fly 1 by aircraft handlers using hand signals, pilots would have used their aircraft's nose wheel steering to manoeuvre within very fine tolerances. In the final stages before shutting down their engines, they would not have been able to see most of the deck under them, and they are parked at an angle so that tractor teams can attach towing arms to nose-oleos and tow them out of Fly 1 for a re-spot. Note the tractor attached to Sea Vixen XJ 526, the third aircraft from the bow on the port side. The aerial projected to starboard by the fourth Sea Vixen is an FU 4, used by the Homing Officer in the Aircraft Direction Room to detect the direction from which any aircraft UHF radio transmission had been made. Right forward on the starboard side is a gantry for an anemometer, used to give accurate wind information for catapult launch calculations. The 'whip' aerial forward of the port 3in gun mounting is a long-range communications aerial in its lowered position. When no flying was in progress it would be raised; it still worked when lowered but was less efficient.

Gannet AEW 3, intended for the airborne early warning role, would not be ready for operational service when *Victorious* was completed. She would have to operate its predecessor, the piston-engined Douglas Skyraider, which also used avgas. Provision therefore had to be made to embark avgas for these two types during the ship's first commission, and suitable tanks were fitted into the after aviation fuel space to meet the required safety standards; however, these had a capacity of only 20,000 gallons (90,920 litres). When the requirement to stow avgas was withdrawn in 1961, the avgas tanks were replaced by bulk avcat stowage, capable of containing 42,800 gallons (194,570 litres), to bring overall avcat tankage to 327,800 gallons (1,490,180 litres).

The Action Information System and Accommodation

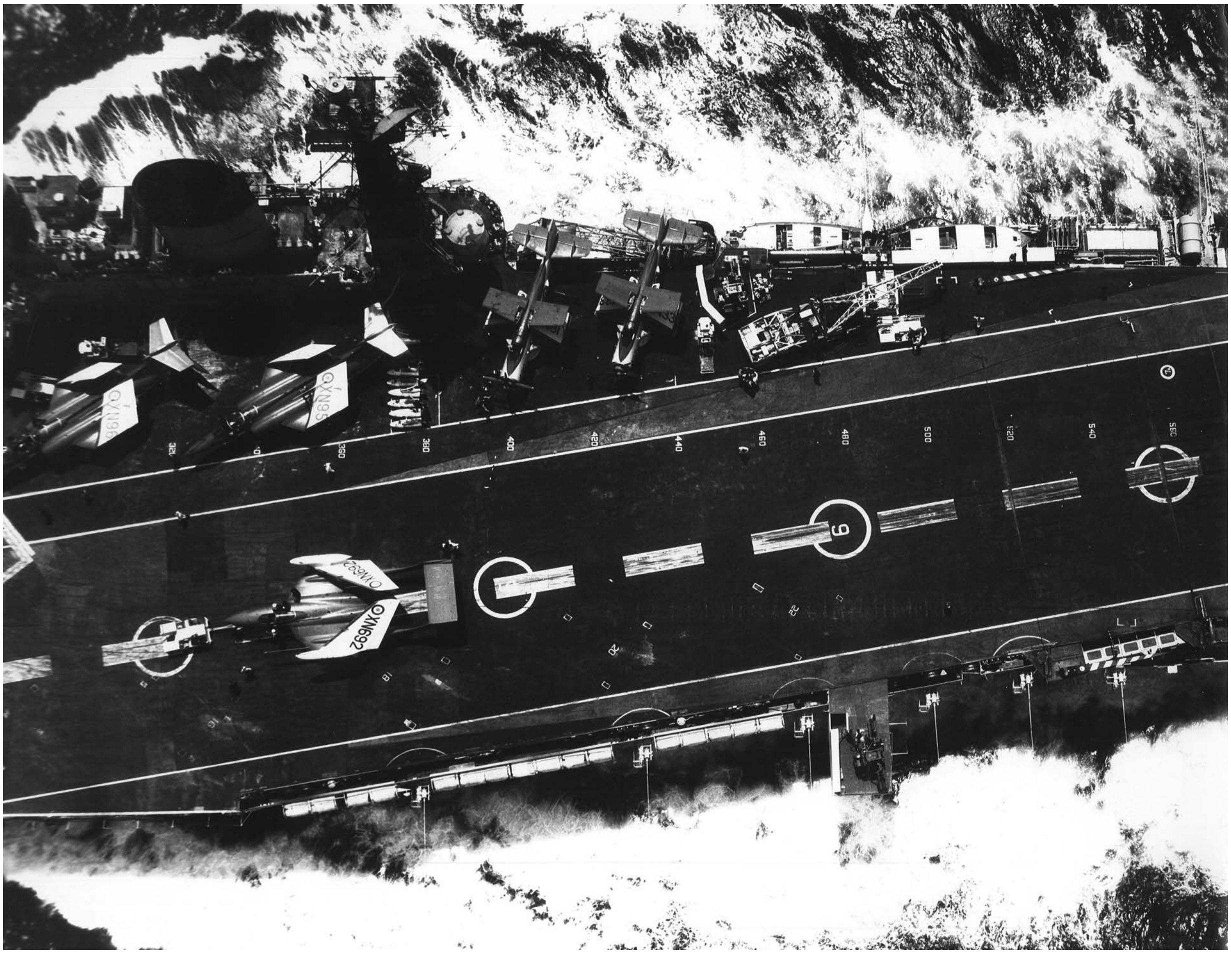
Most equipment built into *Victorious* was new: everything in fact except the anchors and cables, steam turbines and steering gear with its associated rudder, and these were all refurbished. Much had to be learned in Portsmouth Dockyard about project management,



The area of flight deck to starboard, forward of the island was known as the 'graveyard' because it was used to clear aircraft that had gone unserviceable on either catapult, allowing other aircraft in the range clear space to taxi forward and be catapulted. Two Buccaneer S 1s can be seen parked in Fly 2 and two Gannet AEW 3s in Fly 3 aft of the island. The square 'Howdah' from which the catapults were controlled is visible in its lowered position just to starboard of the COD Gannet. Dotted lines painted across the lift served as nose wheel guides to help marshallers accurately direct aircraft taxiing forward from the range onto the two catapult launching positions, and small white lines aft of the catapults show the ideal main wheel positions for the three different types of aircraft that were catapulted. The JBDs with their conspicuous edge markings can be seen in their lowered positions just aft of the forward lift. The small numbers along the centreline were intended to help handlers organise ranges and were marked in 20-foot (6-metre) intervals from the bow. Up to the 300-foot mark they faced forward, from that point they faced aft. Just visible on the forward part of the angled deck are numbered sets of wheel marks painted to help handlers position aircraft into pre-planned ranges.

however, and it was not appreciated until 1953 that new boilers would be needed to power the catapults as well as the propulsion system and electricity generators. Structure that had already been completed, including the armoured flight deck, had to have holes cut in it to allow new boilers to be lowered into place by crane.

Victorious was the first ship to be fitted with an automated command and control system, the Comprehensive Display System (CDS) outfit JZA capable of handling forty-eight tracks. Its sensor was the massive Type 984 radar fitted on top of the island, the world's first complex multi-function radar which used stacked beams with a microwave lens to provide volume search, height-finding, long-range warning and fighter control functions. Simply getting the completed aerial, which weighed 27 tons, through Portsmouth with its narrow streets and overhead trolley-bus wires was a project in its own right before work could even start to install it. Digital Plot Transmission (DPT), an early data link system, was also installed to transmit track information to other CDS-fitted ships such as the aircraft carrier HMS *Hermes* and the first four guided missile destroyers of the 'County' class. *Victorious*' 984/CDS system was reckoned to be five years in advance of USN technology in June 1959 when it was demonstrated to senior USN officers during Exercise 'Riptide' off the eastern coast of the United States.[4] Being early in the field had its drawbacks, however. CDS was reliant on valve technology and outfit JZA included 8,912 valves, 47,400 resistors and 11,750 capacitors. It needed a lot of men to maintain it, but they

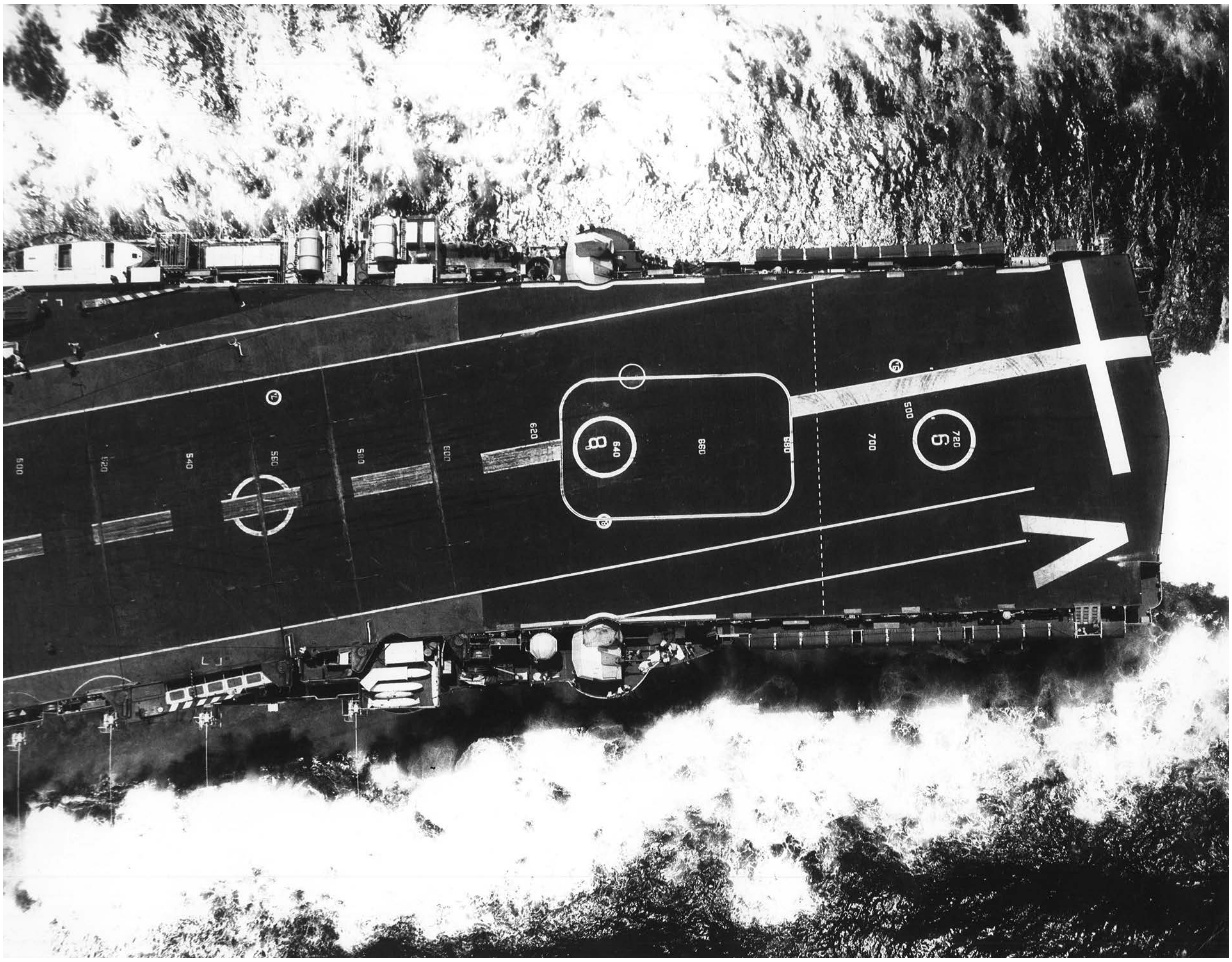


The sponson on the port side of the angled deck for the deck landing projector sight is conspicuous. This replaced the mirror in 1963 and, as its name implied, it featured a projected rather than a reflected 'ball' but gave identical visual cues to pilots. A standby sight was fitted to starboard and this can be seen astern of its protective screen aft of the two Gannets in Fly 3. 'Jumbo' the mobile crane is parked just aft of it, to starboard of the wingtip safety line. Naval inflatable life-raft containers with white covers can be seen along the port deck edge forward of the projector sight sponson and 'whip' aerials can be seen in the lowered position along the port side. These had replaced the earlier 'hockey sticks' which supported the older type of wire communications arrays on the ship's port side in the 1962/63 refit, but 'hockey sticks' were retained on the starboard side where they can be seen in their lowered positions. Note the tops of ship's boats visible in their stowages to starboard, and the line of white Palouste aircraft starter pods in an athwartships row aft of the after Buccaneer in Fly 2 alongside the island.

coped. Some 984/CDS expert technicians proved difficult to replace and spent several commissions on board.

The wartime aircraft operated by *Victorious* had been relatively straightforward to maintain, but the generation of aircraft she was to operate after 1958 needed considerably more men with a wider range of technical skills to maintain them. Workshop space had to be expanded or created to cater for aircraft radar, ejection seats and other complex new systems. Technical complexes had to be made available to prepare guided weapons such as Firestreak, Bullpup and Sidewinder in significant quantities in addition to conventional bombs and rockets, and for the storage and preparation of the Red Beard atomic bomb. Some of this obtruded into the hangar, but the loss of some aircraft stowage space had to be accepted. *Victorious* was the first British warship to deploy both guided missiles and nuclear weapons operationally. Fortunately, manpower was saved by removing the eight 4.5in gun mountings and numerous close-range anti-aircraft weapons and replacing them with six 3in mountings supplied by the USN under MDAP in exchange for information about the ship's design and systems. To cope with potential nuclear warfare, *Victorious* had to be designed with machinery that was capable of being controlled remotely, and part of the hull had to be made into a gas- and radiation-proof citadel.

The new ship's company comprised 2,400 men, significantly more than it had taken to man the original *Victorious*; despite this the Admiralty Board insisted that her accommodation must be completed to the latest standards. Fortuitously, the angled deck sponson and the gallery deck built over the new hangar[5] both provided



The lines where flight deck paint has been rubbed away clearly show the positions of the four arrester wires. The box-like structures that replaced two of the after four 3in gun mountings are clearly visible. That to port has spare drop tanks lashed on top of it, that to starboard has a LOX (liquid oxygen) tank on top of it with another slightly farther forward of it. They were fitted on sledges with quick-release clips so that they could be ditched over the side quickly in the event of a fire on deck. The striped bar shapes visible to port and starboard of the forward arrester wire are the arms for the emergency nylon barrier which could be rigged and raised in under five minutes if an aircraft could not lower its arrester hook. More liferaft stowages can be seen in racks to port and starboard of the after lift. Note that the dayglo-painted angled deck centre line forward of the after lift is scuffed by rubber nose-wheel tyre marks where aircraft slammed into the deck on catching a wire but right aft, below the ideal approach path, it is still in pristine condition. Number 7 helicopter spot has no number because it would have interfered with the centre line marking; number 8 spot is on the after lift platform and number 9 is right aft. There is a tiny sponson on the port side right aft where meteorological balloons were inflated and released.

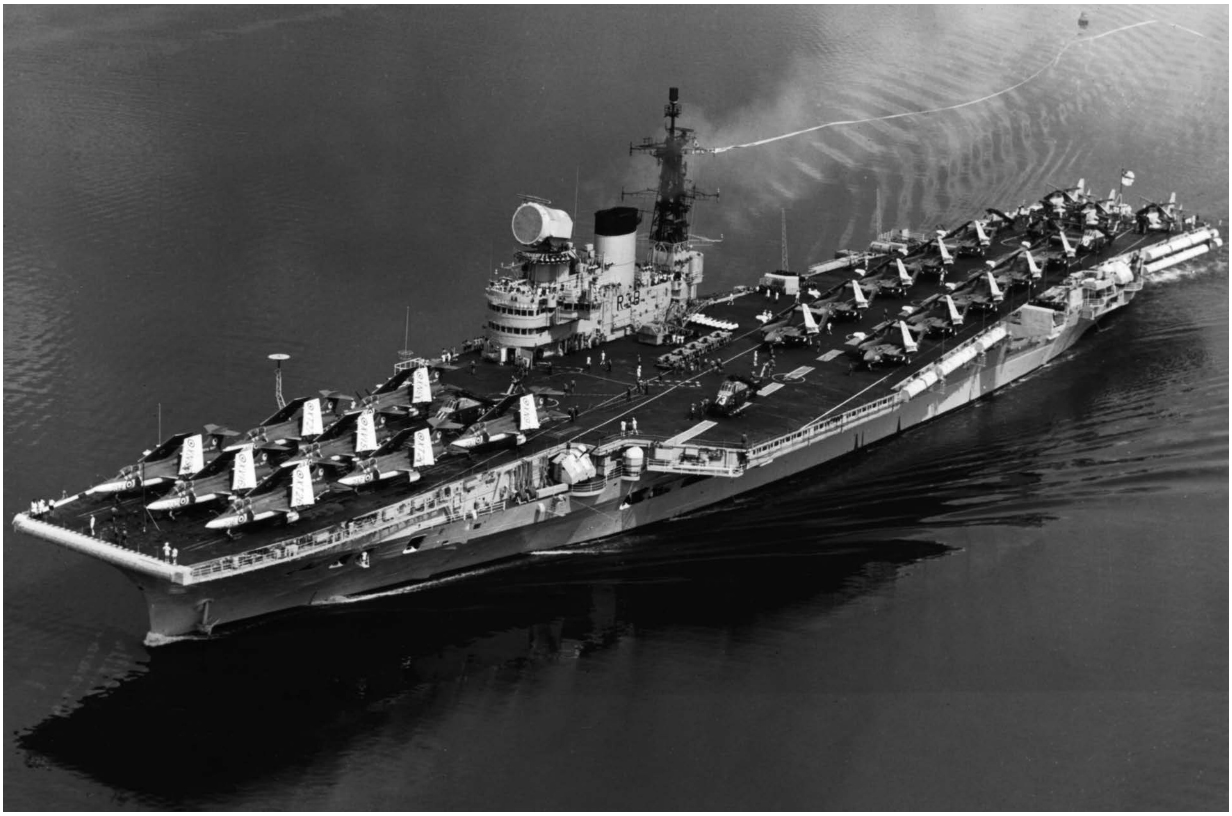
extra hull volume; however, space was always at a premium. On completion in early 1958 *Victorious* arguably had the best standard of accommodation yet achieved in an RN warship. She was the one of the first to feature cafeteria messing, with well-equipped dining halls for both senior and junior rates together with bunks, rather than just somewhere to stow a hammock, for every sailor. The majority of officers had single cabins.

The Focus of Carrier Development

The period during which *Victorious* was reconstructed saw unprecedented advances in aircraft performance and, consequently, aircraft carrier design. A new ship would not have taken as long to complete because changes would not have been constrained by the need to remove old steel-work and equipment, but would still have taken a long time. The *Daily Express* used the headline ‘HMS *Rip Van Winkle*’[6] in an article referring to the ship’s long period in dockyard hands, and questions were asked in Parliament about her prolonged time out of service. However, the timing of her reconstruction proved to be advantageous for the RN, and by 1956 she was the focal point of the British carrier design effort. By then the need to incorporate the new technologies into the carrier fleet was recognised as a complex undertaking that would be difficult to carry forward piecemeal in the operational ships’ normal refit cycles. The sheer scale of the work in progress on *Victorious,* however, made her the only ship that could incorporate the entire package of new technology by the late 1950s, and her completion was eagerly anticipated. While it drove up cost, the work would provide not only the best equipped carrier in the RN, but the only one completely ready to operate the new generation of aircraft and their technologically advanced weapons effectively in the dangerous Cold War period predicted for the late 1950s.

By 1957 the decision had been taken to withdraw all the remaining ships of the *Illustrious* class and the 1942 light fleet carriers, even HMS *Warrior*, which had been modernised with an angled deck for use as a trials carrier; the cost of modifications to enable them to operate new aircraft and their systems was simply too great. Of the carriers begun during the war, HMS *Eagle* had been completed in 1951 to the original straight deck design, and although fitted with an interim angled deck and mirror landing aids she needed an extensive modernisation, due to start in 1958. The 1943 light fleet carriers *Albion*, *Bulwark* and *Centaur* were completed with interim angles and mirrors but were not considered worth reconstructing except for *Centaur*, which was partially modernised with steam catapults and did operate Supermarine Scimitars and de Havilland Sea Vixens in the early 1960s. *Ark Royal* had been the first to be completed with steam catapults, an interim angle and mirrors, but a side lift positioned on the port side amidships had made the fitting of a sponson to support a full angled deck too complex to consider as she neared completion, since it would have delayed her by over a year. She, too, would need modernisation. HMS *Hermes*, last of the 1943 light fleet carriers, had been launched only in 1953 after manpower shortages had delayed her construction. She was then partially dismantled and reconstructed to a new design similar to *Victorious*' which produced a slightly smaller carrier fitted out to an equivalent standard. Her CDS outfit JZB, however, was capable of handling only 32 tracks and she could embark slightly fewer aircraft, 32 rather than 36. She was completed in November 1959, nearly two years after *Victorious*, and her design included a side lift worked into the angled deck sponson.

In 1953 *Victorious*' design was altered to include an angled deck, CDS, Type 984 radar, a new lattice mast to carry other aerials and arrays on the after part of the island structure, and new boilers. In 1954 it was amended again to incorporate a new guided and nuclear weapon preparation space in the hangar, but in 1957 the list of modifications the Admiralty wanted incorporated into her was 'frozen' so that she could be completed in early 1958. Further necessary alterations continued to be listed, however, for incorporation in her first major refit, to which were added the lessons of experience in her first years of operation. Work had still to be done to match her facilities with aircraft systems and weapons that had not been defined when the design was 'frozen', and it was carried out in Portsmouth Dockyard between 1962 and



Victorious in the Johore Strait entering Singapore Naval Base for the last time in 1967. (Author's collection)

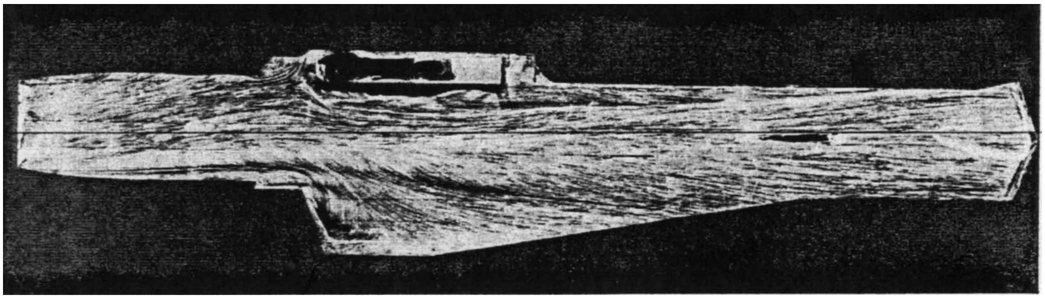
1963. Referred to by the Admiralty as a special refit, it was actually a mini-modernisation, as the modified ship's 'as-fitted' drawings make clear, and included internal changes to workshops, accommodation, magazines, aviation fuel stowage and the incorporation of a liquid oxygen generating facility into a space built into the after hangar to support the de Havilland Sea Vixen FAW 2 and Blackburn Buccaneer S 2 in service. Externally the most obvious changes included the removal of the two forward mountings out of the after group of four 3in gun mountings, together with their directors, with extended accommodation being built out onto the sponson in their stead. A platform, known as the 'Alaskan Highway' was built outboard of the island at flight deck level with a small hangar at its centre in which flight deck tractors and other vehicles could be stowed and maintained. The highway also gave space for armourers to do their work clear of the noise and blast on the deck, and to stow prepared weapons ready to fit them onto aircraft.

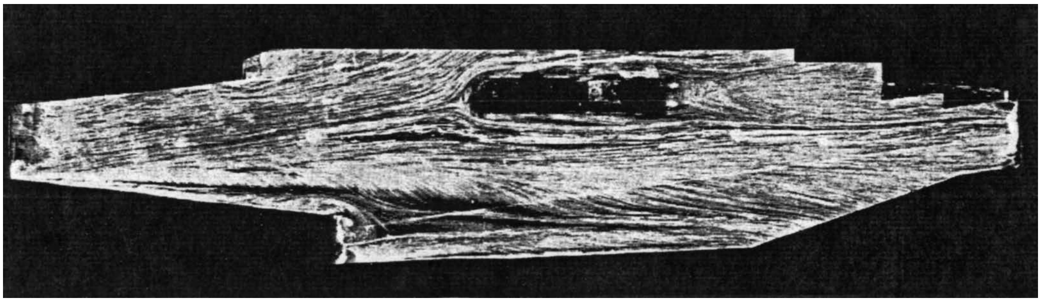
Towards a New Carrier Design

With *Victorious*' design frozen and work being carried out by the DNC's department on the new fleet carrier design that evolved into CVA-01, it was inevitable that focus would shift in 1958 away from *Victorious* to the new design. Clearly it would absorb the lessons learnt in *Victorious* about the operation of advanced strike fighters and the efficient use of volume within the hull, and would take advantage of experience gained during the long reconstruction. In due course CVA-01, which was to have been named HMS *Queen Elizabeth*, became the next advanced carrier design, to be capable of operating the generation of aircraft beyond the Sea Vixen, Buccaneer, Scimitar and Gannet AEW as well as the recently ordered Westland Sea King helicopter.[7] Work study teams went to sea in *Victorious* from 1958 onwards to analyse aircraft movements in the hangar and on the flight deck and to make recommendations for improvements which could be fed into both her own 1962 refit and the new design. It is interesting to see how the flight deck design for the new ship evolved, starting with an 8.75-degree angle like that fitted to *Victorious* built onto a hull that was to be both longer and significantly broader; the largest that could fit into the existing dry-dock facilities in the Royal Dockyards. Wind-tunnel experiments with models of *Victorious* and the evolving new carrier design were carried out to see how the optimum airflow could be achieved over the flight deck and in the approach area astern of the carrier.

Gradual changes inevitably moved the new design away from *Victorious*, however. Like her, the new ship was to have three shafts, but they were laid out on the unit principle with machinery spaces alternated so that action damage to one would leave the others intact. This required separate funnel uptakes from the forward and after boiler rooms which were eventually to be incorporated into mast structures with vortex generators intended to clear smoke away from the flight deck. Separate exhaust systems led to an elongated island, essentially two blocks joined by a hangar at flight deck level for flight deck tractors and machinery that was to open out onto the Alaskan Highway as well as the main flight deck.

The most striking developments, however, were the evolution of the angled deck into a parallel deck angled at only 2 degrees to the left of the centreline, compared with the 8.75 degrees in *Victorious*, and the enlarged Alaskan Highway intended to allow aircraft to taxi or be parked to starboard of the island. The aftermost point of the landing area was moved from the starboard side of the after round-down, as in *Victorious,* to a point near its port side. The new layout had several advantages, the most obvious being the effective movement of the small

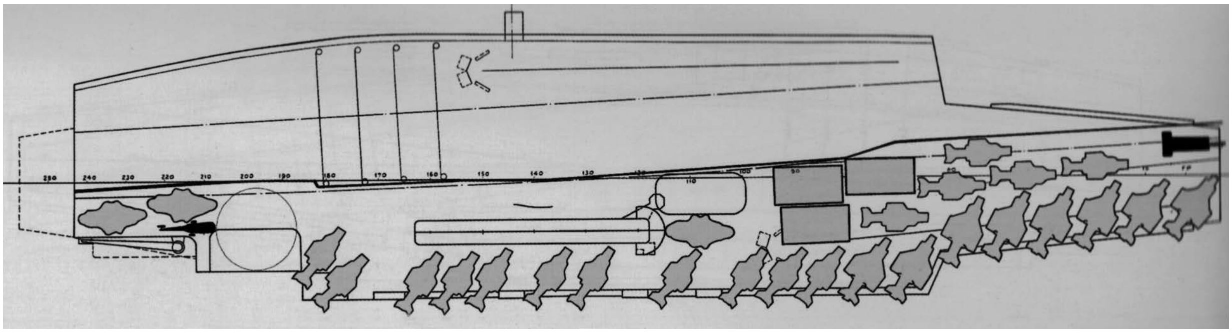




Wind tunnel models of *Victorious* (above) and an early version of the new carrier (below) showing the airflow over the evolving flight deck designs. (Author's collection) parking area Fly 4 from the port side aft to the starboard side where it merged into Fly 3 and Fly 2. These developments followed recommendations made by the fleet work study teams embarked in *Victorious*, which were extensively modelled and approved by the Ships and Bases team on the staff of the Director General Aircraft (Navy). They allowed aircraft to taxi between all the parking areas, and lifts positioned in Fly 1 and Fly 3 were ideally placed to take unserviceable aircraft out of the flow into the hangar. The catapults were positioned with one on the starboard bow and one in the waist aligned along the parallel deck. Both were to BS5 standard, 250 feet (76.2 metres) long and capable of launching aircraft up to 55,000lb (24,950kg) at an end speed of 115 knots (210k/h) relative to the deck. Their arrangement represented the most efficient way of launching aircraft from the range aft; these were brought forward in two streams, one of which could, if required, be outboard of the island to starboard.

The parallel deck offered considerable flexibility, with both catapults used to launch a deck-load strike that could subsequently be landed on in a single recovery, parking aircraft in Fly 1, Fly 2, Fly 3 and the Alaskan Highway after they moved clear of the parallel deck but still keeping both lifts free to strike down aircraft that were unserviceable. Alternatively groups of aircraft could taxi along the Alaskan Highway to be launched from the bow catapult while aircraft landed on the parallel deck, turning into Fly 2 to park. This would have been the first British aircraft carrier designed with a genuine ability to launch and recover aircraft at the same time over prolonged periods. Internally, CVA-01's hull benefited from the experience gained in *Victorious*' reconstruction and first three years of operational service. The enlarged hull would have had a deep load displacement that was about 20,000 tons greater, giving volume for a larger hangar that would be capable of absorbing the expected growth in aircraft dimensions over the next three to four decades, together with significantly increased avcat stowage, magazine volume and space for avionics workshops and weapon preparation areas. Like the modernised HMS *Eagle* she would have had a version of the action data automated weapon system, ADAWS, probably to outfit JZQ standard, but it is likely that an evolved variant of the Type 984 radar would have been fitted rather than the Anglo/Dutch Type 988 which was

Victorious arriving in Malta on 20 July 1966. The author was fallen in with other officers on the forward part of the flight deck. (CPL)



A schematic drawing of the flight deck of CVA-01 showing a possible arrangement of aircraft in the deck parks. The rectangles represent the space required for the Gannet AEW 7 that was expected to replace the Gannet AEW 3. The light grey shapes are Phantoms, Buccaneers and Sea Kings and the black shape forward is 'Jumbo' the mobile crane. The black shape aft is an SAR helicopter, expected at the time to be the Whirlwind HAR 9. (Author's collection)

cancelled by the UK when the Dutch elected not to buy the Sea Dart missile system.[8]

Unfortunately for the RN, politicians equated warship cost to tonnage and this led to ill-informed criticism of the need for a larger hull to replace *Victorious*. In fact, the steel-work of the hull's fabrication amounted to little more than 20% of the total build cost, the greater part of the balance being spent on command, control and communication systems together with other sophisticated electronics, machinery, workshops and weapons test facilities which would have been just as necessary in a smaller hull. 'Cheese-paring' tonnage might have saved 3% of the overall cost but would have produced a cramped ship with a less effective operational capability that would limit future aircraft designs. Also, fitting those electronics into a smaller hull would have required ingenuity and, perhaps, increased cost. We live today in an era when aircraft spend decades in service. RN examples include the BAE Systems Sea Harrier and the Westland Sea King which remained in service for 26 and 49 years respectively; even the earlier Blackburn Buccaneer and Fairey Gannet were in service for 18 years. The Leonardo Merlin has been in service for 20 years and is not due to be retired until 2030 at the earliest. In 1959, when *Victorious* was being successfully demonstrated to the USN and work was being carried forward to make CVA-01 the most efficient ship possible within a tight budget, the Naval Staff expected things to evolve rather differently. Pilots in the Naval Staff had begun their careers flying aircraft such as the Fairey Swordfish, Blackburn Skua and Supermarine Seafire and had taken part in the transition to supersonic jets armed with guided weapons in just two decades. Small wonder that they expected progress in aircraft design to continue at a similar pace and carrier design to be evolved to match that progress. *Victorious* was a good design, but size was already seen to limit her ability to operate the Sea Vixen's replacement, the American McDonnell Phantom, which was expected to have an all-up weight of 56,000lb (25,400kg) when it was ordered in 1963. A new carrier that would still be in service in the 21st century had to improve on *Victorious*, and that meant greater hull volume for expansion to accommodate future aircraft and weapons that were not yet even staff requirements.

Victorious' reconstruction took a long time and cost a lot of money but produced the best British aircraft carrier of her era, a ship at the pinnacle of British carrier technology which formed the basis for a series of design studies for an innovative new carrier. Her only limitation was her size; she was, nevertheless, an extremely happy and effective aircraft carrier and one that the author was proud to serve in as a midshipman during 1966.

Suggested further reading:

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Endnotes:

[1] Hone, Thomas C, Friedman, Norman, Mandeles, Mark D, 'The Development of the Angled Deck Aircraft Carrier', *US Naval War College Review*, Spring 2011, Vol 64 No 2.

[2] Goodhart, HCN, 'Fitting the Aircraft carrier to the Modern Aircraft', *The Vickers Magazine*, Spring 1960.

[3] Hobbs, David, *A Century of Carrier Aviation*, Seaforth Publishing (Barnsley, 2009).

[4] For a full account of the development of CDS, see Peter Marland, 'Post-War AIO and Command Systems in the Royal Navy', *Warship 2016*, 80–83.

[5] The author's recently-published book *Aircraft carrier Victorious: detailed in the original builders' plans* (Seaforth Publishing, 2018) shows these spaces in detail.

[6] The reference is to a short story by Washington Irving about Rip Van Winkle, a Dutch-American villager who slept for twenty years through the American Revolutionary War.

[7] For a detailed description of the design of CVA-01, see Ian Sturton, 'CVA-01: Portrait of a Missing Link', *Warship 2014*, 29–48.

[8] See Jon Wise, 'North Sea Partners', *Warship 2019*, 175–78.

THE BEGINNINGS OF SOVIET NAVAL POWER

Przemysław Budzbon and **Jan Radziemski** investigate the influence of HM Submarine *L 55* on the design of the early Soviet submarines.

Despite earlier experiments with small underwater craft, the Russian Admiralty embarked on submarine development in earnest only when news of the commissioning of the first working combat submarines filtered through in 1900. Thus the Russians began the race in the middle of the peloton, but the poverty of the industrial base and the obscurantist nature of the naval administration would lead to a dead end fifteen years later.

The individual placed in charge of the submarine design team was Ivan Bubnov, at that time deputy of Aleksei Krylov, the internationally-renowned Russian mathematician and theoretician of shipbuilding, and head of the testing tank at Saint Petersburg. The initial project materialised in June 1903 with the first diving trials of a 113/124-ton submarine boat to be named *Delfin*. The submarine configuration that evolved during the next decade in consecutive projects led by Bubnov laid the foundations for the so-called 'Russian Type'. Key features that differentiated the submarines from contemporary foreign designs were as follows:

- main ballast tanks (MBT) placed at both ends in the light structures outside the pressure hull; they were fitted with scuttles to facilitate their use as additional quarters when not in operation; inboard vented, they were flooded and emptied using ballast pumps instead of gravitational flow
- no subdivision of the pressure hull – a feature of foreign submarines obstinately resisted by Bubnov
- hull lines that comprised a cylindrical hull amidships, with truncated cones fore and aft capped with torpedo boat shapes at the ends
- drop-collar torpedo launch mechanisms.

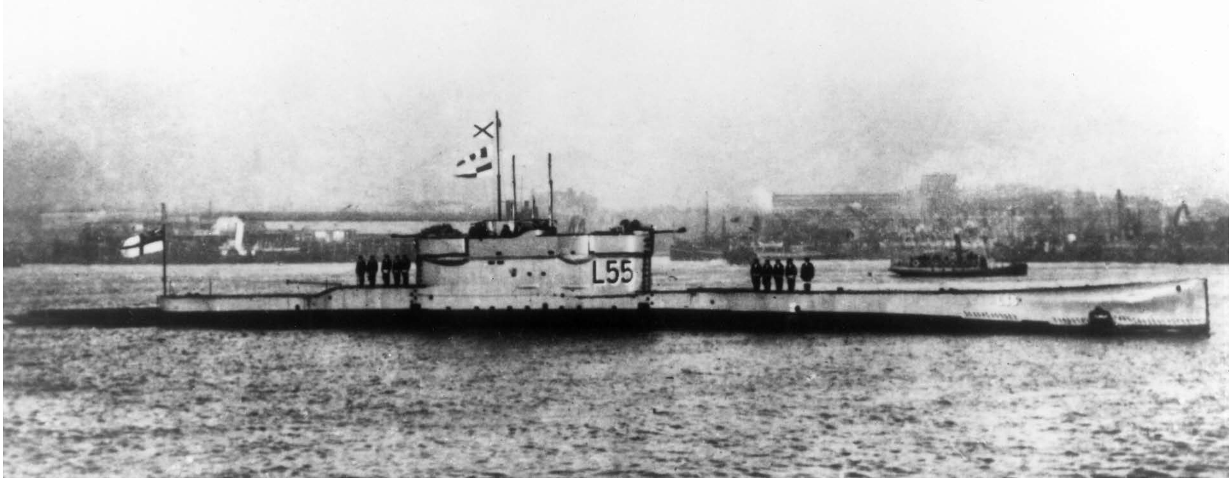
These features have not been favourably judged by history. Bubnov succeeded in imposing the Russian Type designs due to the influence and favour he enjoyed with the establishment. His greatest accomplishment was the series of 24 submarines of the *Bars* class built in various Russian shipyards during 1913–17; these boats marked the culmination of the design shortcomings of the earlier boats.

The Submarine Navigation Department (*Otdel Podvodnovo Plavaniia* – known also by its acronym *Podplav*) was set up in 1906 at the Baltic Works in Saint Petersburg, and had general responsibility for the entire design and construction process. Bubnov was put in charge; he would later be replaced by his brother as constructor, while retaining responsibility for design. As Bubnov, like other submarine inventors of the day, considered his designs to be his own personal intellectual property, he did not choose to share workshop secrets even with his closest colleagues. Moreover, part of the design work was done in an office located in his private apartments. In this way practically all the submarine expertise in Russia was concentrated in the hands of one family.

The brothers Bubnov left the Baltic Works shipyard in 1912 for the private Noblessner Works of Revel, where Ivan was hired as a consultant. Although Bubnov continued to provide support services to *Podplav*, he jealously guarded his general design knowledge. Thus when the future leader of early submarine development in the Soviet Union, the newly-graduated Boris Malinin, joined *Podplav* in 1914, nobody shared this information with him. During the war he accumulated a fair amount of experience as a constructor, being part of the team working on the detailed drawings for the submarines of the *Bars* class. He would go on to supervise the construction of eight boats of this class, the modification of several more, and the re-activation of the British 'C' class submarines delivered on barges from Archangel. He became head of the Technical Bureau of *Podplav* in October 1917, on the eve of Bolshevik coup.

A New Vision

The disorganisation of the Russian state, together with the introduction of so-called 'war communism' rules, disrupted the logistical network essential for the construction of sophisticated warships. All the shipyards were nationalised and looted, and production came to a standstill when most of skilled workers were mobilised or fled to the countryside to avoid starvation. The engineering staff either shared their fate or emigrated to avoid the persecution focused on the 'elites'. The Baltic Works was switched to the repair and production of rolling stock for the railways. When Bubnov caught typhus fever while travelling by train and succumbed in March 1919, he left no students who had worked under him and no works of submarine theory, calculation methodology or explanatory notes. Only a few serviceable boats remained, and the workshop drawings survived in the archives of the Baltic Works. Thus the ability to build



L 55 leaving HMS *Dolphin*, Gosport, shortly after her entry into service, with the Admiralty flags displaying 'L 55' in the 1918 code; six months later she was sunk in Koporskaia Bay. This poor-quality image is one of only two known photographs of the submarine in RN service prior to her sinking. (Royal Navy Submarine Museum)

submarines in Russia effectively ceased. Even Krylov, praised in Russia as a genius, had no grasp of submarine theory. *Podplav*, which from October 1922 was under Malinin's supervision, produced only a few sketch designs that were no more than theoretical proposals.

Following the formation of the Soviet Union in December 1922, the key issue for Bolshevik leaders became the struggle for Lenin's heritage, and control over the armed forces was one of the key battlefields. Fresh memories of the 1921 Kronstadt rebellion emphasised to the Soviet high command the necessity of securing the political loyalty of the Navy over and above its technical reconstruction – the Navy lost its independent status and was renamed 'Naval Forces of the Workers' and Peasants' Red Army' (MS RKKA). There were doctrinal discussions reflecting the political struggle on the future role of the Navy; however, nothing happened in the field of new construction. With no prospect of obtaining orders, the Baltic Works dissolved *Podplav* in October 1924, the staff being transferred to the general Technical Bureau of the shipyard. Malinin became responsible for repairs and modifications to a handful of existing submarines.

Loss of control over the Red Army by Trotsky in March 1924 ended for a time the battle for supremacy between the various Bolshevik leaders and opened the way for a general purge, later described as 'military reform' by the Soviet historiography. The command structures of the Navy were reorganised, and more than 750 officers purged or removed, while half of the remainder had no proper naval experience or training. Nevertheless, this was recognised as progress, and the next step was to be the development of new materiel.

Picking Up the Pieces

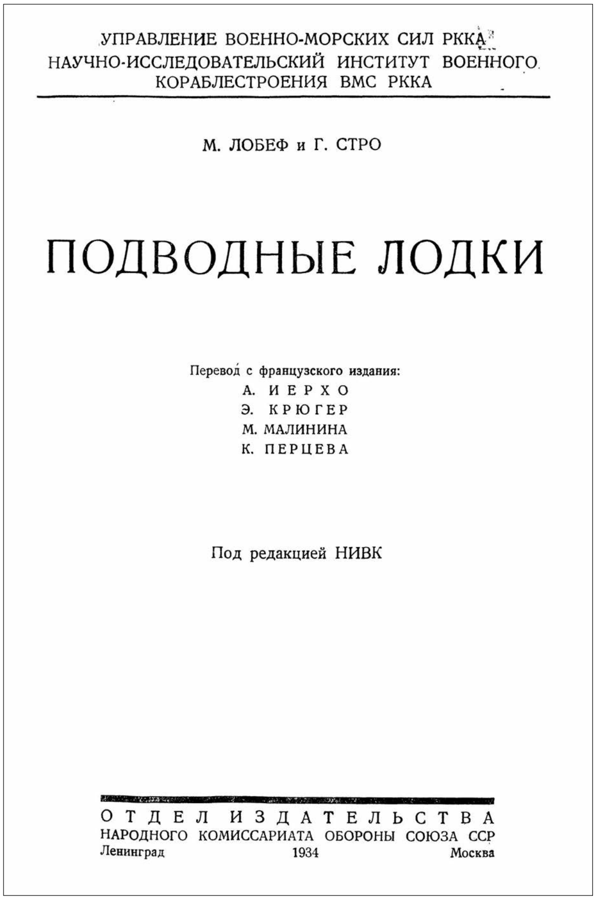
The Soviet Government (*Sovnarkom*, or 'Council of People's Commissars') decreed the design and construction of submarines. The doctrinal dilemma – whether to opt for a 'sea control' fleet' or a 'mosquito fleet' with submarines – was resolved by purges of those members of the officer class that favoured the former, while those who survived trimmed their sails to better catch the winds of opportunity.

Taking into account the lessons learned from German U-boat operations during the First World War, the Staff of the Red Army issued in January 1925 the first tactical and operational guidelines for the development of three types of submarine. The design study task was assigned to the Naval Scientific-Technical Committee (acronym: NTKM), which was assembled from the prominent shipbuilding experts who remained in the country after 1917. They were wise enough to include Malinin, together with the most experienced submarine commanders, to work on the technical aspects of future boats.

This proved to be easier said than done. A solid grasp of general theory and the ability to apply it to the design process is fundamental to the success of any submarine project. With the death of Bubnov this knowledge simply disappeared from Russia. The first thought was therefore to purchase designs and prototypes from abroad. For a while this seemed feasible, as by the mid-1920s the Soviet state was on the way to overcoming its international pariah status. The private shipyards Franco Tosi and Ansaldo in Italy, the British Vickers and the Dutch Fijenoord were requested to submit proposals. However, the reluctance of the potential suppliers to share know-how combined with the limited foreign currency holdings of the Soviet Union to prevent this idea from coming to fruition. An attempt to secure the services of Professor Oswald Flamm, the leading naval architect of the German U-boat fleet of the First World War, likewise met with failure.

Another opportunity to short-circuit the design process seemed possible through the well-established secret military co-operation with the *Reichswehr*, which in 1923 set up a permanent office in Moscow known as the *Zentrale Moskau*. Initiated under Trotsky, this collaboration was continued by his successors. The German C-in-C Admiral Paul Behncke (commander of the 3rd Battle Squadron at Jutland) visited Moscow in February 1924, and the two navies conducted joint exercises off the Polish coast in September. But the *Marineleitung* (German Naval Command) became less enthusiastic when it became clear to them that potential co-operation with the Red Navy had little to offer the *Reichsmarine*. The Soviets had to wait until April 1925 to obtain some very general documentation relating to German submarine warfare doctrine; this did little to address the urgency of the situation.

Underhand methods had to be employed. In 1925 a delegation from *Sudotrest* (the Shipbuilding Trust, an organisation grouping all machinery and steel construction activity formed in 1921), headed by Krylov, was despatched to western Europe in a bid to acquire mercantile tonnage and to set up possible co-operation with Denmark, Germany, France and Italy. Malinin was an undercover member of the delegation. In Germany he obtained practically nothing except of a copy of an 1887 booklet entitled *Submarine Boats* by William Hovgaard and the 1920 edition of *Hilfsbuch für den Schiffbau* by Johow and Foerster. But in Italy he hit gold: a copy of the book *Sous-marins, torpilles et mines* by Maxime Laubeuf and Henri-Charles Stroh in the 1923 updated edition. This very basic companion was to lay the foundations of Soviet submarine power. The fact that it was translated and published in Moscow ten years later can be seen as evidence both of its importance to the Russians and of their limited knowledge of submarine theory at that time. In the same second-hand bookshop in Rome Malinin purchased a general arrangement plan of the Italian submarine *Balilla*. This Fiat–Laurenti boat had been ordered by the *Kaiserliche Marine* and launched in 1913 at Fiat's San Giorgio shipyard as *U-42*, but following the outbreak of war she was offered to Spain, then taken over by the *Regia Marina* after Italy entered the war.



УПРАВЛЕНИЕ ВОЕННО-МОРСКИХ СИЛ РККА
НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЙ ИНСТИТУТ ВОЕННОГО
КОРАБЛЕСТРОЕНИЯ ВМС РККА

М. ЛОБЕФ и Г. СТРО

ПОДВОДНЫЕ ЛОДКИ

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Под редакцией НИВК

ОТДЕЛ ИЗДАТЕЛЬСТВА
НАРОДНОГО КОМИССАРИАТА ОБОРОНЫ СОЮЗА ССР
Ленинград 1934 Москва

Front page of the Russian translation of the 1923 edition of *Sous-marins, torpilles et mines* by Maxime Laubeuf and Henri-Charles Stroh, published in Moscow eleven years later. Malinin and Kriuger were among the translators.

A Reluctant German Rescue

Following these somewhat desperate attempts to gather theoretical knowledge, in January 1926 the NTKM began work on the preliminary design studies of what would later become the first Soviet submarine. Prospects for success were poor due to limited Soviet knowhow and experience, and foreign assistance was still considered essential. This opportunity occurred when Germany and the Soviet Union embarked on talks that aimed to extend the Treaty of Rapallo in the spring of 1926. Taking advantage of the thaw in relations between the two countries, the Soviet Ambassador in Berlin arranged in March a secret conference headed by Iosif Unshlikht, at that time deputy to the head of *Revvoensovet*, the Revolutionary War Soviet – the highest Soviet military authority – and General Hans von Seeckt, a head of the German *Reichswehr.* As a result, on 25 March a meeting was held between retired U-boat commander *Konteradmiral* Arno Spindler, 'unofficially' representing *Marineleitung*, and NTKM representative Paul Oras, who was multi-lingual, cosmopolitan and a former *Gardermarin* in the Imperial Navy. His role was to charm his counterparts and convince them to help the Soviets. He even proposed the joint construction of submarines in the Soviet Union, but the Germans rejected this on the grounds of the limitations of Treaty of Versailles.

The irony of this was that Spindler at that time headed the secret U-boat department (codenamed 'Au') of the *Marineleitung*. The Germans agreed to deliver machinery and equipment and invited Oras to the *Ingenieurskantoor voor Scheepsbouw* (known as IvS) in The Hague, the clandestine German submarine design operation launched by AG Vulcan, Friedrich Krupp Germaniawerft and AG Weser. The visit took place on 2 April and Oras left with sketch plans for a submarine of 600 tonnes. In this new spirit of cooperation Spindler went to Moscow in June to meet Soviet officials, including the C-in-C of the Naval Forces (acronym: *Namorsi*) Viacheslav Zoff. The latter repeated requests for plans of German First World War submarines, and added a request for plans of project Pu111 (the Turkish

E-1) drawn up by IvS together with the assistance of three experts, covering submarine command, construction and engines. German reluctance to meet these requests was understandable, as it was not in their strategic interest to create naval rival in the Baltic. It was only as a result of strong political pressure that the plans of four First World War submarine types (*UB III*, *Ms*, *U-139* and one of the *UC* designs) were despatched to Moscow in July and handed over via *Zentrale Moskau*.

Learning on the Job

NTKM now had several possible patterns to follow as it undertook the design process, as well as information and advice. Equally valuable were product brochures from Atlas-Werke, MAN, Siemens-Schuckertwerke, Mannesmannröhren-Werke, Bamag and Brown–Boveri. A total of 32 project variants were prepared, but restrictions imposed by available propulsion machinery limited outcomes to two different types: a high-speed fleet submarine of 1,400 tonnes and a patrol submarine of 890 tonnes with half the propulsion plant of the first, both armed with six 450mm torpedo tubes.

Both projects were formally presented in September 1926 during a special session of the Naval Academy in Leningrad organised by the new *Namorsi*, Romuald Muklevich. Senior commanders of the Navy and the Baltic Naval Forces attended the session. The recommendation was for the patrol type, which was considered to be the right size for the Gulf of Finland, being able to operate within the Baltic skerries. An increase in the diameter of the torpedo tubes to 21in was insisted upon, despite the lack of any production capability for 21in torpedoes in the Soviet Union at that time. Kliment Voroshilov, the head of *Revvoensovet*, approved the choice some weeks later. Shortly afterwards Muklevich authorised two additional bow torpedo tubes and a change from hydraulic torpedo launch to a compressed air system.

These initiatives received the official stamp of approval on 26 November 1926, when the Council of Work and Defence (the Bolshevik agency responsible for the central management of the economy and production of military materiel) formally authorised the first Soviet Naval Programme for the years 1926–32. New construction in the first *tranche* (1926–30) included six submarines, with a further six in the second (1927–32). As usual, these plans did not survive for long, and a lack of connection with reality meant that their scale was increased a few months later: when authorised in June 1927 plans were for 16 patrol and three medium-type boats.

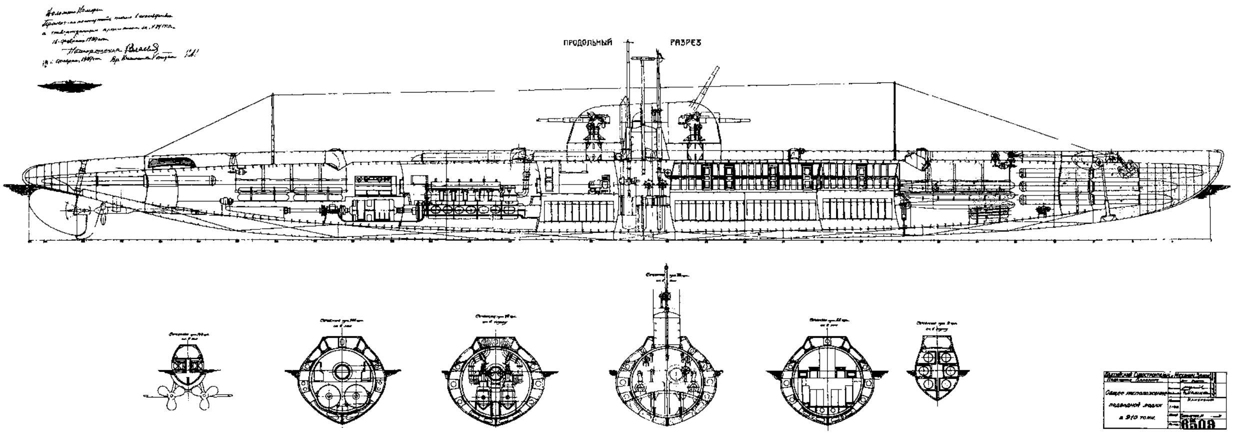
Within the week the construction/design bureau *Tekhnicheskoe Biuro No 4* (TB-4) was set up at the Baltic Works, charged with the design and construction of the first Soviet submarines. The name *Podplav* was back in use. It was headed by Malinin (project management, naval architecture, pressure hull, buoyancy and manoeuvrability). His relatively small team comprised two engineers, Ernest Kriuger (machinery and deck fittings) and Aleksandr Shcheglov (outer hull, tanks, stability), and four draughtsmen. They were joined in March 1927 by the newly-graduated Sergey Bazilevskii (intact stability, spherical bulkheads, ballasting systems). Electrical systems were to be the responsibility of the shipyard's Technical Bureau. Work began in earnest, and a display of revolutionary zeal was expected. When in January 1927 the prospect of obtaining MAN diesels was confirmed – they were ordered under the cover of propulsion for the E^{el} type locomotive – it appeared that the last barrier to submarine construction had been removed.

In order to meet the ambitious production deadlines, preliminary and detailed design had to be undertaken in parallel with construction. Malinin was compelled to begin the preparation of workshop drawings before the GA and body plans had been approved. By the time workshop drawings of the midship section of the pressure hull were ready in March 1927, three keels had already been laid at the Baltic Works. The first hull (Yard No 177) was named *Dekabrist* and became the nameship for the class. Three further keels were laid the following month at the Andre Marti Works (former Naval Shipyard) at Nikolaev on the Black Sea. Thus construction proceeded in parallel with the conceptual and technical design of structures and systems.

Design

Following design changes the surfaced displacement rose to 910 tonnes. The boat would be of the double-hull type, with subdivision of the pressure hull copied from that of *Balilla*. The internal hull was divided into seven compartments by spherical bulkheads with a cylindrical conning tower atop and a vertical keel beneath. There were trim tanks at either end of the pressure hull and a small tank placed amidships. The latter was copied from *Balilla* and was for rapid diving, but its purpose was not clear to the Russians at that time. The tank was intended to be used when the boat was at periscope depth in the event of an attempt to ram by a surface ship; it was therefore sized at only 0.5 per cent of total displacement. The outer hull casing covered the whole length and had a raked stem, but without bow flare or sheer. Six pairs of gravity-filled main ballast tanks were symmetrically placed in the space between the hulls on both sides; each pair was equipped with a common Kingston valve and a common outboard vent. The *Bars* class arrangement of two deck ballast tanks placed on top of the pressure hull in the casing abaft the conning tower was retained.

The diesel/electric power plant had a two-shaft arrangement with three-bladed propellers, the electric motors being located in the large after compartment together with the stern torpedo tubes. The main storage batteries were distributed between three hull compartments under a gas-tight fixed steel floor. They were placed in rooms on either side of the boat with a passageway between them. The battery tanks had their own independent ventilation system; this restricted the height of the accommodation spaces above. The bow



910-tonne Submarine: Profile and Sections

General Arrangement of the 910-tonne submarine with 4in shielded guns at either end of the bridge fairing. Cross sections from left to right: frame 144 looking forward, frame 105 looking forward, frame 88 looking aft, frame 73 looking forward, frame 55 looking forward, and frame 9 looking aft. (Frames were numbered from the bow.)

The plan was issued by the Submarine Department of the Baltic Shipbuilding and Mechanical Works, signed by Malinin and approved by Muklevich on 16 February 1927.

hydroplanes were hinged and located above the waterline. The semi-balanced rudder had its axis inclined forward by 7 degrees; it was intended to act as a hydroplane when the boat was at full helm, helping to keep boat submerged. Two 4in guns were mounted on deck at either end of the bridge fairwater and housed in streamlined shields. There were six fixed 21in torpedo tubes in the bow and two aft.

Construction of the pressure hull placed a heavy burden on Malinin. The design depth was to be 90 metres, a first for Russia and almost double that of the *Bars* class. The calculation methodology had to be devised from scratch by trial and error. The only guidance could be found in Maxime Laubeuf's book: the Marbec method suggested there was used to predict bending moment and stresses. This was then re-checked by applying the von Mises yield criterion, using Southwell's relaxation method of solving equations. However, 'beyond this was the unknown', as one contemporary witness stated.

At least three methods used by Malinin to reduce the risk factor could be traced, and they testify to a legitimate lack of self-confidence. The shape of the pressure hull repeated the streamlined lines of the single-hull *Bars* class. That was irrelevant in the case of the double-hull type and the solution needlessly complicated construction: every sheet of plating had to bent individually using a manual process of spot heating to match the template. This costly and labour-intensive solution has been explained by naval historians as the result either of inexperience or failure to think things through. The authors are convinced that it was a form of life insurance for Malinin. He was taking on a high personal risk by being in charge of the innovative submarine construction project. The choice of the proven *Bars* hull, scaling its dimensions and design depth up for 90 metres, appears to have been a conscious decision. In order to ease the construction process, frame spacing was increased from 12in (305mm) to 500mm – thus changing the second strength calculation parameter. It was therefore less risky to keep the shape unchanged rather than take risks with the third parameter. Increased labour costs were irrelevant in the context of the Soviet economy, and in any case this was outside Malinin's area of responsibility.

The second measure undertaken was the use of the stock of steel assembled before 1917 for the construction of the *Kinburn* class battle cruisers; this avoided the risk of the low-quality steel milling processes available during the late 1920s. For the Soviet Union prior to 1991 the term 'pre-revolutionary' often meant 'reliable' and 'high quality'.

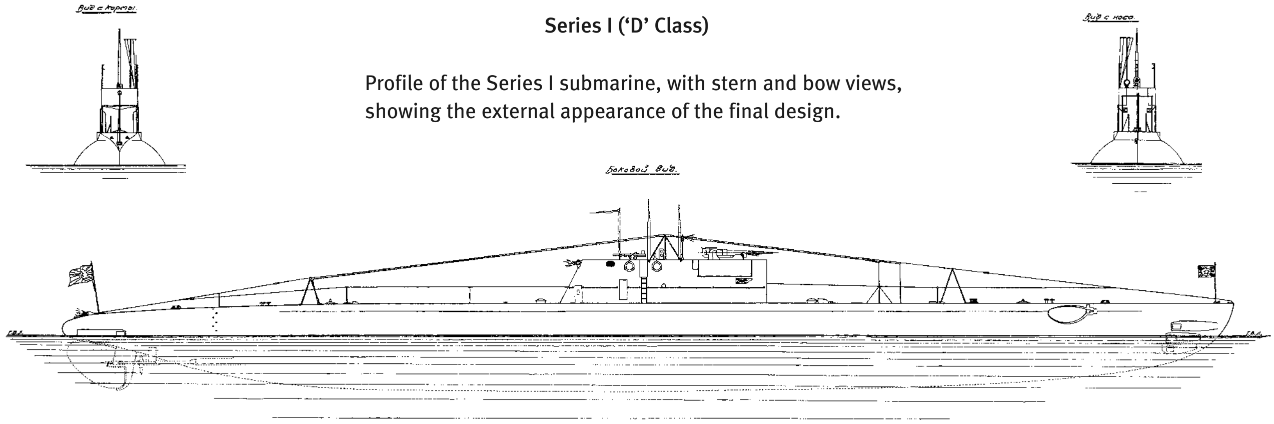
The third risk reduction factor was the adoption of lifesaving features for the crew. Both end compartments were designed as emergency escape chambers, with bulkheads calculated to withstand a pressure of 9 atmospheres – the other bulkheads were designed for 2atm. The crew could be evacuated through torpedo tubes or hatches. Individual breathing apparatus was provided for the whole crew. Two rescue buoys were fitted as well as eyes to help raise the ship and bollards to moor rescue pontoons. Last but not least were the pressure air valves mounted on the sides; they could be used to blow the main ballast tanks from outside or to deliver air inside the pressure hull.

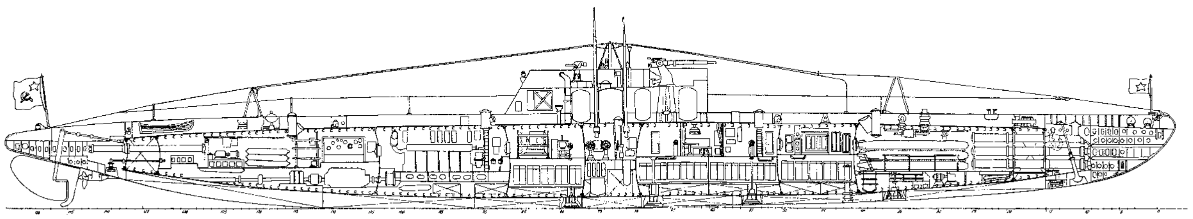
The Discovery of the Wreck of *L 55*

The problematic aspects of the design concerned not only the strength of the pressure hull, but the internal systems. The small size of the team proved to be a bottleneck, and the addition of one more graduate who joined in May 1927 failed to unblock it, given that his specialism was aircraft construction. The first task he was given was the design of the Kingston valves, with

Series I ('D' Class)

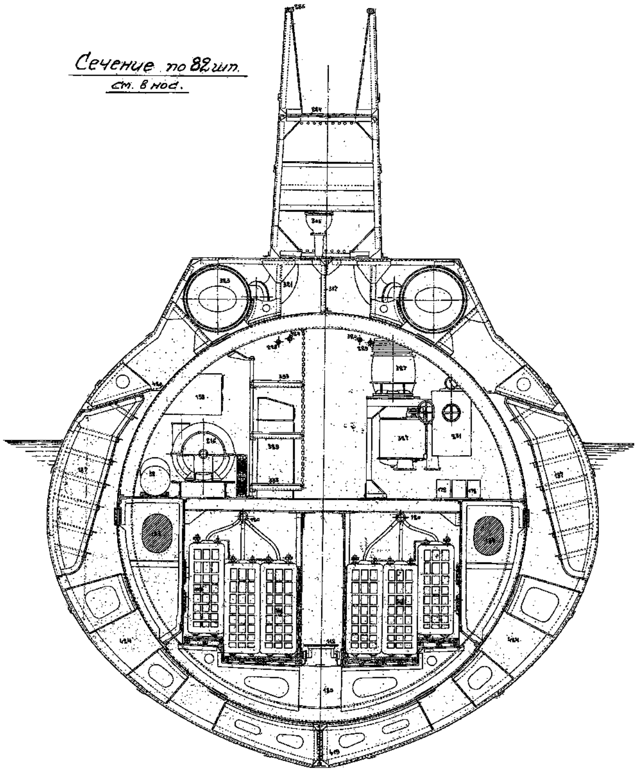
Profile of the Series I submarine, with stern and bow views, showing the external appearance of the final design.





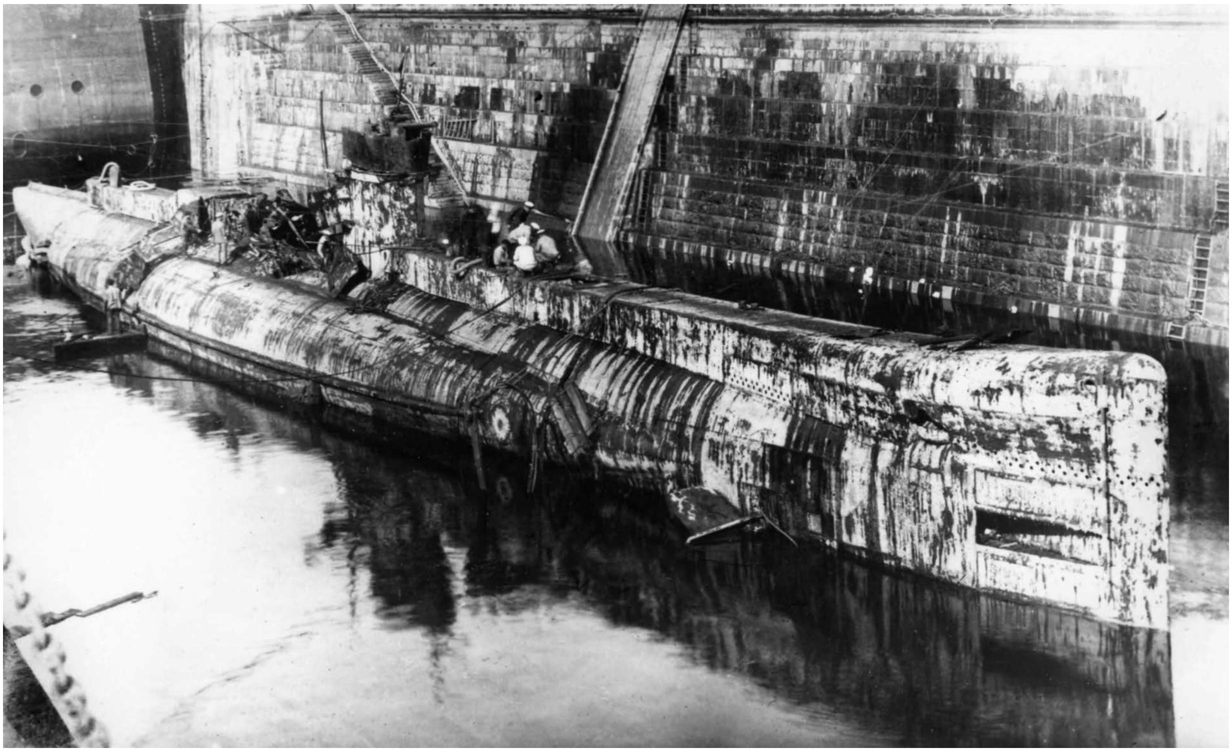
Above: The inboard profile depicts the 'as fitted' configuration of the three Series I Baltic Yard boats with a slight change to the shape of the stem. This change was probably planned as the first attempt at modernisation, but the final modifications were to go much further.

As compared with the 910-tonne design, a new bridge arrangement is in evidence, with one 4in and one 37 mm AA gun. Buoyancy tanks were fitted within the bridge casing in an attempt to improve buoyancy when dived. The internal arrangement of the hull is practically the same, except for the replacement of the spherical collision bulkheads by flat bulkheads in the final design. This drawing and the external views were published in SA Bazilevskii, *U kolybeli podvodnogo flota. Zapiski konstruktora* (*In the Cradle of Submarine Fleet: Notes of the Constructor*.)



Series I ('D' Class): Section

Right: Cross-section of the Series I as-fitted design at frame 82 looking forward. The enclosed battery tank is in evidence, likewise the limited height of the compartments above. Note the corridor between the battery banks and the tight double bottom space.



The wreck of *L 55* shortly after her salvage, in the Dok Veleshchinskogo (formerly Dok Tsesarevitcha Alekseia Nikolaevicha) at the Kronstadt Naval Dockyard, lying close to the dock gates. The extent of the damage can be clearly seen. She was docked here on 12 August 1928; the water was pumped out by the evening of the same day, and the hatches were opened for the first time the following day. The number 'L 55' is barely visible on the remains of the bridge casing, which was later cleaned to display the number for a propaganda film. *Namorsi* Muklevich visited the wreck on 16 August to announce the salvage to the press, so the photo will have been taken between 13 and 15 August at the latest, while the water pooling on the bottom of the dock suggests the earlier date. *L 55* was moved to another dock on 23 August 1928. (Boris Lemachko collection)

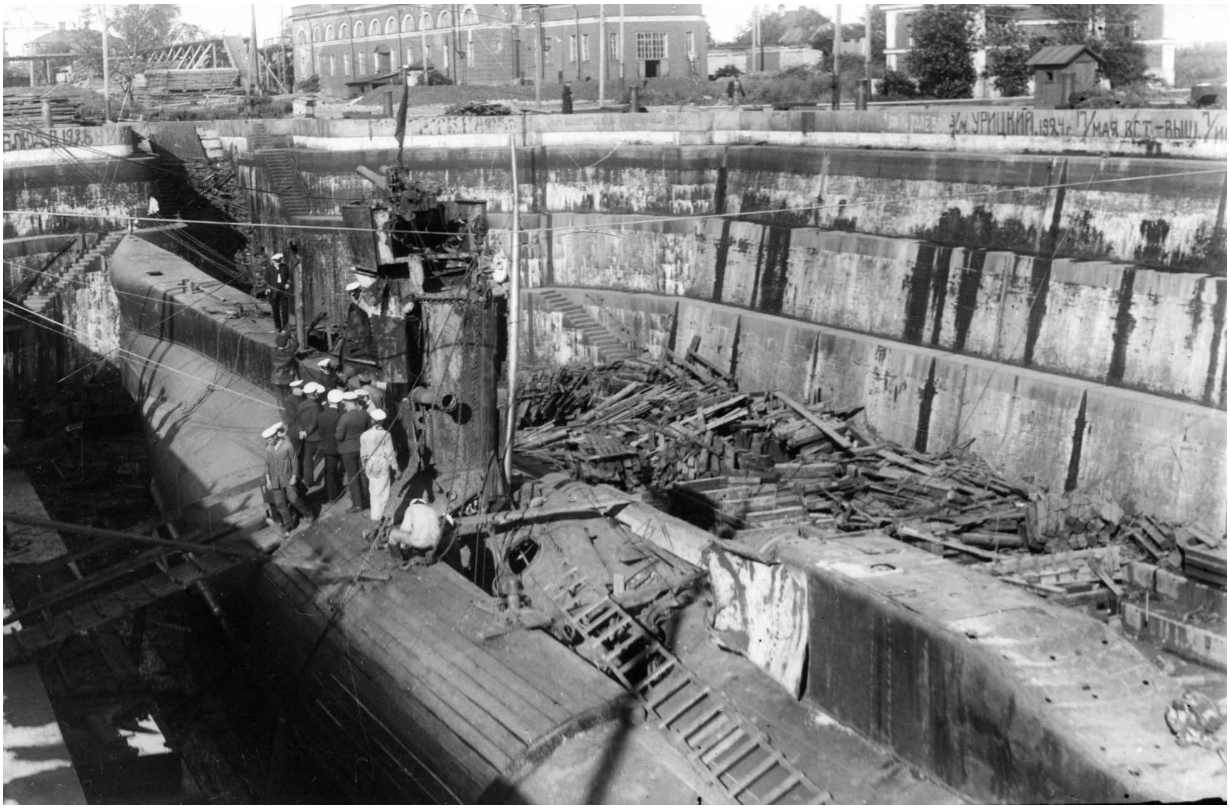
which he was totally unfamiliar. There was a complete library of the *Bars* workshop drawings available at the Baltic Works, so the majority of the internal systems, devices and equipment were simply copied or adapted. The team's output issue was aggravated by the lack of standard industrial products (or of any standards at all), so almost every fitting or part not copied from the *Bars* had to be designed from scratch, drawn and then manufactured in a small series. The workshop drawings ran into tens of thousands, resulting in overwork, hurried execution and, inevitably, errors.

With work on the the hulls painfully slow, the NTKM added a new task by embarking in March 1927 on a preliminary design study for a 'combined type submarine', combining a strong torpedo armament with the ability to lay mines. This project, planned for the second *tranche* of the Programme, was designated Series II, with the *Dekabrist* class receiving the retrospective designation Series I. It was assumed that there would be maximum commonality between the two type, so the key project issue was to be the minelaying system. This was decided a year later in favour of Malinin's concept of dry-storage horizontal launch tubes fitted aft – as in the German UE type, but with a rope winch instead of a cog drive.

By November 1927 the hulls of the *Dekabrist* class had been on the slipways for nine months but were still a long way from launch. The inexperience of the design team and the frailty of Soviet industry were responsible for this situation. However, Malinin then had a lucky break: a gun sight dredged up by minesweepers the previous year proved to be that of the British submarine *L 55*, sunk in 1919 in Koporskaia Bay.

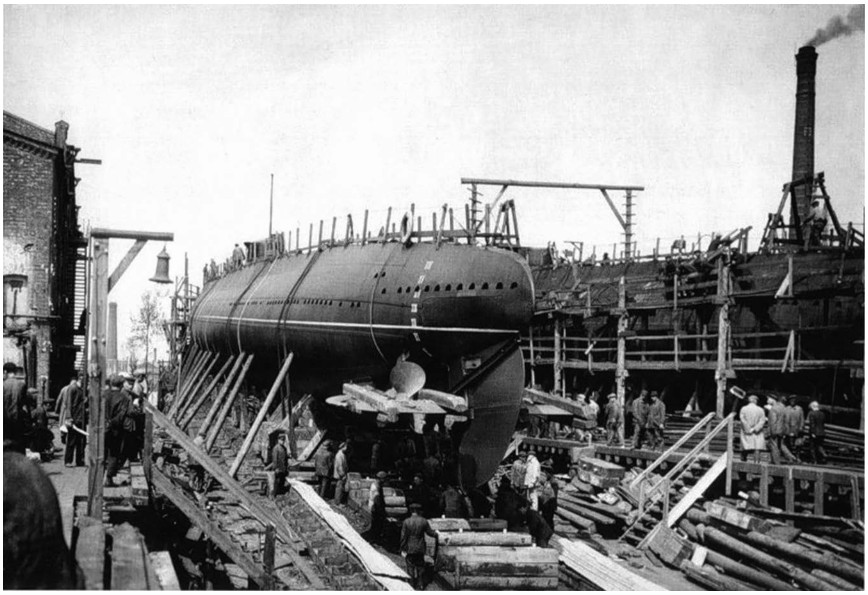
The news electrified everyone responsible for the submarine construction programme. According to a statement by Voroshilov, *L 55*, built in 1919, 'represents the latest technology of the leading naval power and embodies the war experience of the victorious Royal Navy'. Construction of the *L 50* class continued until 1923, and the boats remained in service during the late 1920s, surviving the postwar reductions in the strength of the Royal Navy. Moreover, in January 1928 two modified boats of the class were delivered to the navy of the Kingdom of SHS, which became Yugoslavia in 1929. The wreck of *L 55* was located immediately and raised in August 1928 (see the article by the author and the late Boris V Lemachko in *Warship* No 45, Jan 1988).

The Baltic Works – much to the dissatisfaction of the management, which was already preoccupied with construction of the *Dekabrist* class – was given the responsibility for the reconstruction of *L 55*, which was

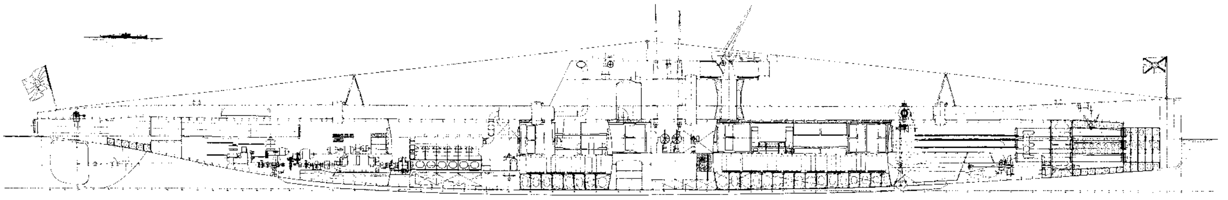


L 55 already cleaned up and moved to the Mitrofanov Dok (former Aleksandrovskii Dok). Interestingly, at the head of the dock the remains of ships' names with the dates of docking can be seen. The most legible at the right top is the name of the destroyer *Uritskii*. (Boris Lemachko collection)

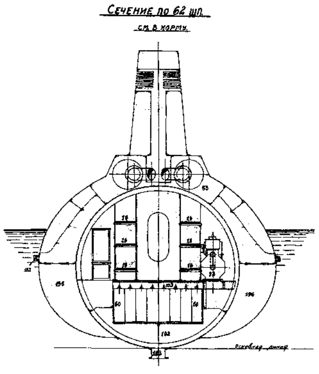
awarded to Malinin's team. During their inspection of *L 55*, more than one thousand drawings and schemas of her internal systems and fittings were prepared, and the new Soviet submarine designs revised accordingly. More than 40 sets of manuals were found, while the contents of notebooks belonging to the British officers were also significant: to their astonishment the Russians found German torpedo-firing settings and tables dating from 1917. However, shipbuilding technology and naval architecture were to be only part of the booty: almost the whole Soviet naval armaments industry was enriched with equipment to be examined and copied:



Yard No 179 of Series I prior to launch at the Baltic Works in the summer of 1929. (Authors' collection)



Series II (‘L’ Class): Inboard Profile
Inboard profile of the original Series II design.



Series II (‘L’ Class): Section
Cross-section of the Series II design at frame 62, looking forward. As compared with Series I, the battery tank is now an open compartment covered with planking, and the submarine has only a partial double hull.

- The torpedo firing mechanisms were sent to the Karl Marx Works (former New Lessner).
- Two 21in torpedoes were presented to the Dvigatel Works (former GA Lessner) and the Frunze Military Academy respectively.
- Torpedo control parts were given to the *Ostekhburo* (the organisation set up in 1921 and responsible for the development of new kinds of weaponry), which at the time was working on improvements of the defective prototype of the first Soviet 21in torpedo, subsequently designated *Type 53–27*.

Table 1: **Soviet Submarines Laid Down and Completed 1927 – July 1941**

Note: Medium, patrol and fleet types are included.

Class	Series	Number laid down by 22 Jun ‘41	Year laid down	Number completed by 22 Jun ‘41	Remarks
Dekabrist	I	6	1927	6	Modifications to design influenced by *L 55*.
Leninets	II	6	1929–30	6	Design influenced by *L 55*.
	XI	6	1934	6	
	XIII	7	1935	7	
	XIII-38	6	1938	0	
Shchuka	III	4	1930–34	4	Reduced copy of *L 55*.
	V	12	1932–34	12	
	V-bis	13	1932–35	13	
	V-bis2	14	1933–36	14	
	X	32	1934–36	32	
	X-bis	13	1938–41	2	
Pravda	IV	3	1931–36	3	Design elements based on *L 55*.
*N / S**	IX	3	1934–36	3	IvS design.
*from 1937	IX-bis	47	1936–41	15	
	XVI	6	1941	0	
K	XIV	12	1936–38	6	New design.

Specification	Number laid down by 22 Jun ‘41	% of Total	Number completed by 22 Jun ‘41	% of Total
Overall total	190	–	129	–
Influenced by *L 55*	122	64%	105	81%
Including *Shch* class copied from *L 55*	88	46%	77	60%

Total numbers in the lower table are indicators of the trend. When the Red Navy entered the Second World War, 81% of the newly-built submarines (not including coastal types) had been influenced by *L 55*, while 73% (60% of total) of this number were reduced copies of the British design. By the Second World War the influence of *L 55* was diminishing in favour of IvS designs, but it was still the dominant factor in Soviet submarine design between the wars.

- Five 21in torpedoes were sent for testing at torpedo firing stations to compare their performance with the *Type 53–27*.
- Periscopes were shared with the TOMP Works (formerly the Russian optic instruments factory).
- Parts of the hull shell were sent to the Leningrad Test Tank.
- The 4in guns were delivered to the Bolshevik Works (formerly Obukhov).
- Samples of the batteries and their associated components were sent to the Leitenant Shmidt Works (formerly TEM).

The Russians were obsessed with the tactical value of high speed, and had been particularly impressed by the surface speed of the *L 50* class, which according to *Jane's* was 17 knots. However, testing would have to await the reconstruction of *L 55*, which took three years.

Dekabrist, after 20 months on the slipway, was launched in November 1928. It was too late to include many of the lessons learned from *L 55* in the construction of the hull, but this remained a possibility for much of the boat's systems and equipment. The time necessary to study *L 55* and to absorb the lessons, together with the weakness of Soviet industry, meant that not all these features could be adopted. Soviet equipment manufacturers had long delivery times and an inbuilt resistance to change. They were commissioned to deliver a set number of components at a fixed price, so changes were perceived as obstacles rather than opportunities.

The most noticeable external change to the *Dekabrist* class was the bridge fairwater, which was remodelled to imitate the layout of the British submarine. However, because of the stability issues involved in relocating both guns one deck higher, the after 4in gun was replaced by a 37mm AA gun.

The Influence of *L 55* on the New Designs

In order to gain the time to make the necessary investigations and draw conclusions, the keel laying of the Series II submarines was postponed until the spring of 1929. A project study for a new medium-type submarine designated Series III and authorised in June 1927 was likewise delayed.

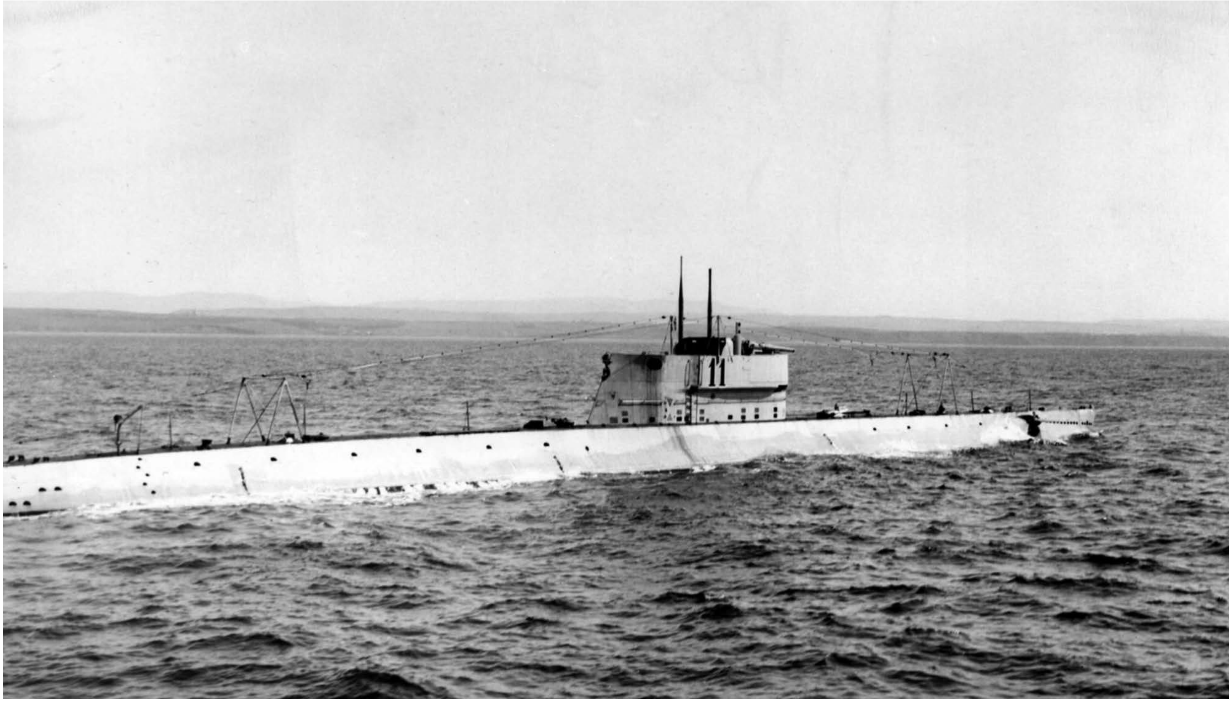
Of these two projects it was Series III that gained the most from *L 55*. However, both types abandoned the *Bars*-like streamlined pressure hull – a survey of the hull plating and scantlings suggested that Malinin could rely on his strength calculation methods. The pressure hull of the Series II boats was subdivided into six compartments by four spherical bulkheads and one flat bulkhead. Series III initially had five compartments (later changed to six), but all with flat bulkheads as in *L 55*. Both types introduced large torpedo loading hatches, while the abandonment of the tapered pressure hull gave more space for torpedo tubes at both ends.

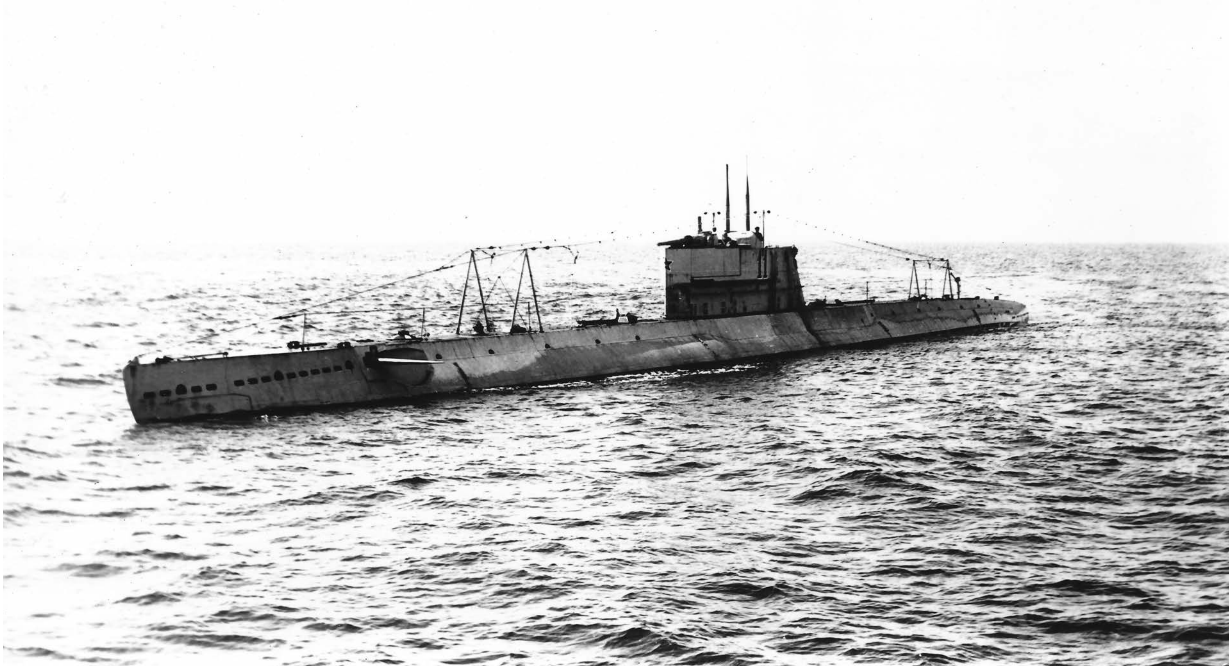
Double hull construction was repeated on the Series II boats except for the bottom, due to production difficulties experienced with the tight double-bottom spaces of *Dekabrist*. Series III was of a pure Admiralty saddle tank type with the body plan being a linearly rescaled copy of *L 55*. Both types combined a straight stem with a raised forecastle, giving them a characteristic British appearance.

Table 2: **Design Characteristics of the Early Soviet Submarines**

Specification	Series I	Series II	Series III	Series IV
Date of specification	17 Feb 1937	late 1928	23 Jan 1930	23 Nov 1930
Displacement, normal [tonnes]	910 / 1,200	989 / 1,276	572 / 672	932 / 1,682
Reserve of buoyancy [%]	45	29	22	81
Length oa [m]	76.6	78.0	57.0	90.0
Beam oa [m]	6.4	7.2	6.2	8.0
Draught, mean [m]	3.76	3.96	3.76	2.83
No of shafts	2	2	2	2
Diesel engines	2 x MAN F6V	2 x 42BM6	2 x W8V28/38	2 x MAN M10V 1 aux 685hp
Total power of diesel engines [bhp]	2,200	2,200	1,000	6,085
Electric motors	2 x PGV	2 x PG-84/50	2 x PGV8	2 x PG–84/95
Total power of electric motors [hp]	1,050	1,300	800	1,100
Battery banks	2 x 60 DK	3 x 112 LS	2 x 56 KSM-2	4 x 112 EK
Maximum speed [knots]	16.0 / 10.0	15.5 / 9.0	14.0 / 8.5?	24.3 / 11.0
Radius surfaced [nm at kts]	7,000 at 10.0	1,000 at 15.5	3,000 at 8.5	1,650 at 10
Radius submerged [nm at kts]	150 at 3.0	150 at 3.0	110 at 3.0	100 at 5.0
Operational diving depth [m]	75	75	75	–
Crushing depth [m]	90	90	90	45
21in TTs	6 bow / 2 stern	6 bow	4 bow / 2 stern	4 bow / 2 stern
Reloads	6	6	4	4
Mines	–	20 x PLT	–	–
Main guns	2 x 4in B-2	1 x 4in B-2	–	2 x 130mm B-7
AA guns	–	1 x 37mm 11-K	1 x 37mm 11-K	1 x 37mm 11-K
Complement	53	55	41	56

The GA plan of the Series II submarines dating from 1929 – christened the *Leninets* class – showed a bridge shaped as in *Dekabrist* and *L 55*, with the 4in gun mounted at the level of the bridge and surrounded by a solid bulwark. This feature, which was costly in terms of topweight, was intended to provide protection for the gun crew against waves washing over the casing when operating in the North Sea. For submarines operating in the Baltic and Black Seas this solution proved to be unnecessary, and the increased topweight threatened stability; the Russians therefore gradually distanced themselves from that solution. The Series II boats were completed with the gun bolted to the pressure hull but retained the bulwark. *Shchuka*, the prototype of Series





The Black Sea Series I prototype *Revoliutsioner* during a presentation for the press in February 1932. She displays tactical number 11 on the bridge, marking her out as the first boat of the First Submarine Squadron of the newly formed Submarine Brigade of the Naval Forces of the Black Sea. The Second Squadron consisted of the old Holland-type submarines at that time. (Boris Lemachko collection)

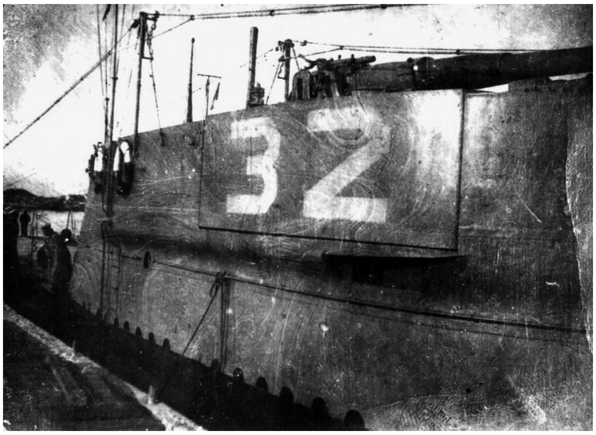
III, had her main 37mm gun mounted on a platform half the height of the bridge deck and retained the bulwark, which was removed following trials. During the reconstruction of late 1930s the *Dekabrist* class had their guns moved to the deck with no bulwark at all.

Equally important modifications were made internally, including:

- battery housing in a recess covered only with planking and linoleum, which allowed an increase in the height of the living quarters above
- no separate battery ventilation system
- separate electric cruise motors geared to the shafts
- boosters installed in the lighting and electrical equipment circuits
- substitution of steel for brass and copper in the construction of the torpedo tubes and the piping for the water and ventilation systems (Series II only)
- water cooling and silencers for the diesel exhausts
- an enlarged rapid-dive tank in Series III (1,5% of displacement) following discovery of its role(!).

Some solutions were thoughtlessly copied without taking into account the specific conditions in which *L 55* was built. For example, the use of steel piping for water and ventilation systems was forced on the British because of war shortages of rare metals, and the Soviets reverted to brass and copper for later construction. The same applied to the battery tanks, and the Soviets reverted to a closed space in later designs after hydrogen explosions occurred on three submarines during early 1930s. (The excessive emission of hydrogen was a consequence of the low quality of Soviet-made batteries and unsafe charging practices.)

The new designs retained some traditional features due to the inexperience of the design team: both had the deck ballast tanks characteristic of the 'Russian Type'. There were, moreover, features of *L 55* that were considered inferior to Russian practice, notably the absence of escape hatches, the lack of an air regeneration system and the method of securing bulkhead doors, which was considered unwieldy.



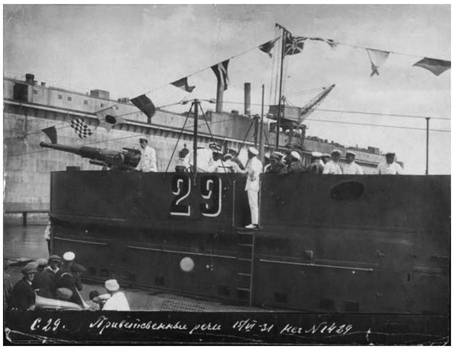
Close-up of the bridge of *Narodovolets* displaying details of her 4in B-2 type gun; a 37 mm 11-K anti-aircraft gun was planned but entry into service did not materialise. The tactical number 32 indicates that she was the second boat of the Third Submarine Squadron of the Naval Forces of the Baltic Sea, formed on 14 November 1931. On 28 December 1932 the three Series I boats formed the Second Squadron so her number was changed to 22, while the Series II submarine *Stalinets* took her place and number in the Third Squadron. (Authors' collection)

L 55 to the Rescue

Postponed to await the *L 55* findings, the preliminary project of Series III was hurriedly put together by

Table 3: **Building Dates of the Early Soviet Submarines**

Series	Name as laid down	Builder	Yard No	Laid down	Launched	Accepted
I	*Dekabrist*	Baltic Works	177	5 Mar 1927	3 Nov 1928	12 Nov 1930
	Narodovolets	Baltic Works	178	5 Mar 1927	19 May 1929	6 Sep 1931
	Krasnogvardeets	Baltic Works	179	5 Mar 1927	12 Jul 1929	1 Oct 1931
	Revoliutsioner	A Marti	S-27	14 Apr 1927	16 Apr 1929	30 Dec 1930
	Spartakovets	A Marti	S-28	14 Apr 1927	28 Sep 1929	5 Apr 1931
	Iakobinets	A Marti	S-29	14 Apr 1927	12 May 1930	15 Jun 1931
II	*Leninets*	Baltic Works	195	6 Sep 1929	28 Feb 1931	22 Oct 1933
	Marksist	Baltic Works	196	6 Sep 1929	21 May 1931	24 Oct 1933
	Bolshevik	Baltic Works	197	6 Sep 1929	8 Jul 1931	5 Nov 1933
	Garibaldiets	A Marti	S-31	15 Mar 1930	31 Aug 1931	8 Oct 1933
	Chartist	A Marti	S-32	15 Mar 1930	5 Jun 1932	30 Oct 1933
	Karbonarii	A Marti	S-33	15 Apr 1930	3 Nov 1932	9 May 1933
III	*Shchuka*	Baltic Works	199	5 Feb 1930	1 Dec 1930	11 Oct 1933
	Okun	Baltic Works	200	5 Feb 1930	6 Nov 1931	11 Oct 1933
	Ersh	Baltic Works	201	5 Feb 1930	6 Nov 1931	15 Nov 1933
	Iaz	Krasnoe Sormovo	550/1	23 Feb 1930	2 May 1931	15 Aug 1934
IV	*Pravdist*	Baltic Works	218	21 May 1931	3 Jan 1934	9 Jun 1936
	Chekist	Baltic Works	219	19 Dec 1931	15 Apr 1935	9 Jul 1936
	Iskrovets	Baltic Works	220	19 Dec 1931	4 Dec 1934	9 Jul 1936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С.29. Приветсвенные речи 15/VI-31 нег. №1429

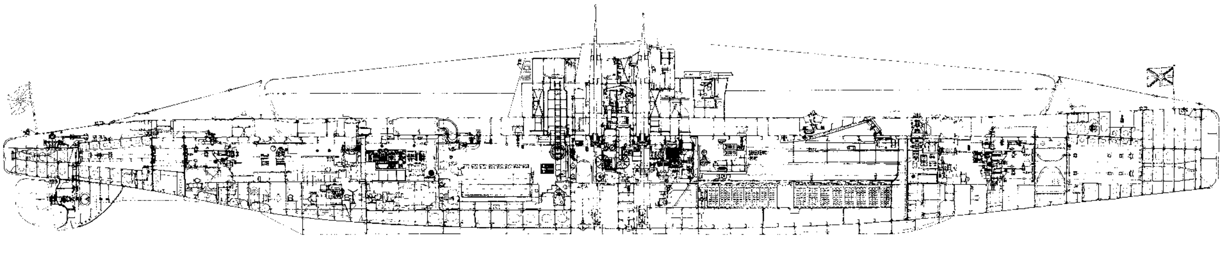
The handing-over ceremony of *Iakobinets* on 15 June 1931, held at the docks of the Andre Marti Works at Nikolaev. The speaker is deputy commander Savich Foma Maglich, later the commander of submarines and squadrons; he was sentenced and executed in 1950 for praising President Tito of Yugoslavia. The 4in B-2 type main gun is displayed in all its glory, while the 37 mm 11-K gun is absent; the latter was planned as a re-barrelled version of the Vickers 2pdr HA Mk II delivered to Russia during the First World War; fifty were ordered in 1928, but only five had been delivered by 1934. The number '29' is actually the yard number, to be replaced by number 13 following entry to service as the third boat of the First Submarine Squadron of the Submarine Brigade of the Naval Forces of the Black Sea. This small print became known only recently when published on the Russian naval enthusiasts' forum 'Tsushima'. (Authors collection)

NTKM and transferred to *Podplav* in an unfinished state. Malinin's team completed it by the end of 1929, and in order meet the programme deadlines, which were now under serious pressure, the workshop drawings were undertaken immediately without waiting for approval of the general design. The prototype was laid down in February 1930, before the project had been formally approved – such was the Soviet reality of those years when Stalin's grip tightened. The country found itself under mounting pressure from forced collectivisation and Stalin's terror tactics while attempting to implement the unrealistic targets of the first five-year industrial plan. Industry managerial staff were working in the shadow of the Shakhty Trial of 1928, the hidden agenda of which was to cover up the bottlenecks resulting from central planning. Fifty Russian and three German technicians were tried publicly on the charge of 'wrecking' the industrial effort, with five death sentences meted out. In consequence terrified industrial managers, rather than adopting optimal and rational resource planning, preferred to conform to unrealistic, often contradictory plans and orders emanating from poorly-coordinated authorities.

The first hint of trouble came from Nikolayev, where *Revoliutsioner* was the most advanced of the Series I boats. During static diving trials undertaken in dry dock the boat took on a pronounced list. A commission was set up by NTKM on 13 March 1930 comprising the most prominent shipbuilding theoreticians of the time, including Krylov. However, they came up with conflicting explanations, and their advice was intended primarily to deflect blame from themselves. Afraid to put forward possible measures that might not work, the commission attempted to suggest that the problem was unresolvable and that all the hulls already building should be scrapped.

The phenomenon of a 25-degree list during diving of the German U-Cruisers was known to the Russians at that time, thanks to a 'Professional Note' in the March 1924 issue of the *US Naval Institute Proceedings*, which was cited in the Russian *Morskoi Sbornik*. This problem, which affected the double-hull *U-139* and *U-142*, was a real concern for the German naval architect Flamm. On the other hand, the British 'K' and 'M' classes designed by Sir Arthur Johns, which featured a partial double hull, were praised for being able to dive without any loss of stability. Nobody, including Malinin, was able to diagnose the cause.

The story of the first official trials of *Dekabrist*, conducted in May 1930, is worth telling because it illustrates the lack of expertise and self-confidence of the submarine staff. During early trials, on opening the Kingston valves the boat took on a 3-degree list to starboard, which was eliminated when the main ballast tanks were blown. In order to reduce the apparent risk, it was decided to continue diving using tanks 2 and 5 only, which was contrary to the diving manual. When the Kingstons were opened the list occurred again, although this time only by 1.5 degrees. Considering the issue partially 'solved', the vents were opened and in a short time the list increased to 18 degrees. An attempt to blow the tanks resulted in a further increase, so it was decided to pump out the starboard fresh water tank and the torpedo tubes. The list was reduced to 3 degrees but the boat then swung rapidly 21 degrees to port. That was considered excessive, and shipwrights were summoned. They dismounted the vents in tanks 2 and 5 and blocked off the venting pipes of the starboard tanks with wooden



Series III ('Shch' Class): Inboard Profile

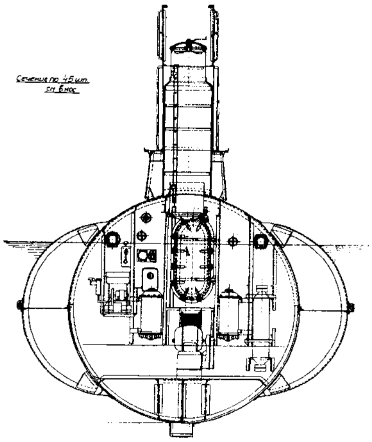
Inboard profile of the Series III design, featuring a 37mm gun mounted on a platform with a solid bulwark forward of the bridge. This reconstruction, by Tomasz Grotnik and Przemysław Budzbon, is based on the original profile and bridge layout plans.

plugs. Water from the port tanks was then pumped out until the boat was righted. The trials commission considered *Dekabrist* not only non-operational but dangerous.

This was an uncomfortable situation for Muklevich, as failure of the construction programme would endanger him personally. In mid-July he went to sea in *Dekabrist*. His conclusion, apparently dictated by a desire to save his own skin, was that the boat was fully safe despite ‘some’ stability issues during diving and surfacing. He blamed the inexperience of the crew and the trials commission, and an ‘excessive trust in the theoretical calculations of Malinin’. There was a ‘need for more serious and systematic investigation of the achievements of foreign technology’, which in practice meant further studies of *L 55*. Following his meeting with the local OGPU (secret police, later known as the NKVD, then the KGB), Malinin, Kriuger and Bazilevskii were arrested on 27 July 1930 and accused of ‘wrecking’ the project. They were joined in the dock by Ksenofont Ruberovskii, General Manager of the Baltic Works, which had been closed since February.

With the help of the ‘wreckers’ a ‘get-well’ programme was undertaken. The approach can only be described as overkill, in that it was hoped that a a scattergun series of measures would somehow bring about the required result:

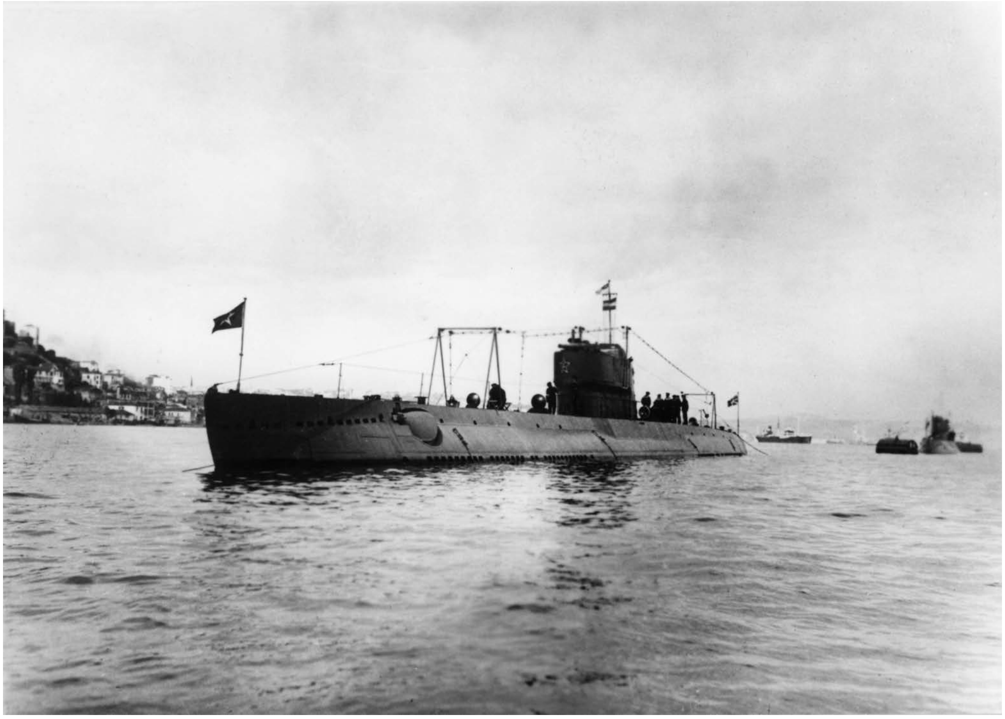
- The inclinometer was calibrated on the slipway.
- The initial list to starboard of 3 degrees, which resulted from an asymmetrical distribution of weights, was eliminated by embarking ballast in the form of pig iron to port.
- The port and starboard main ballast tanks were separated to prevent free-flooding between the tanks.



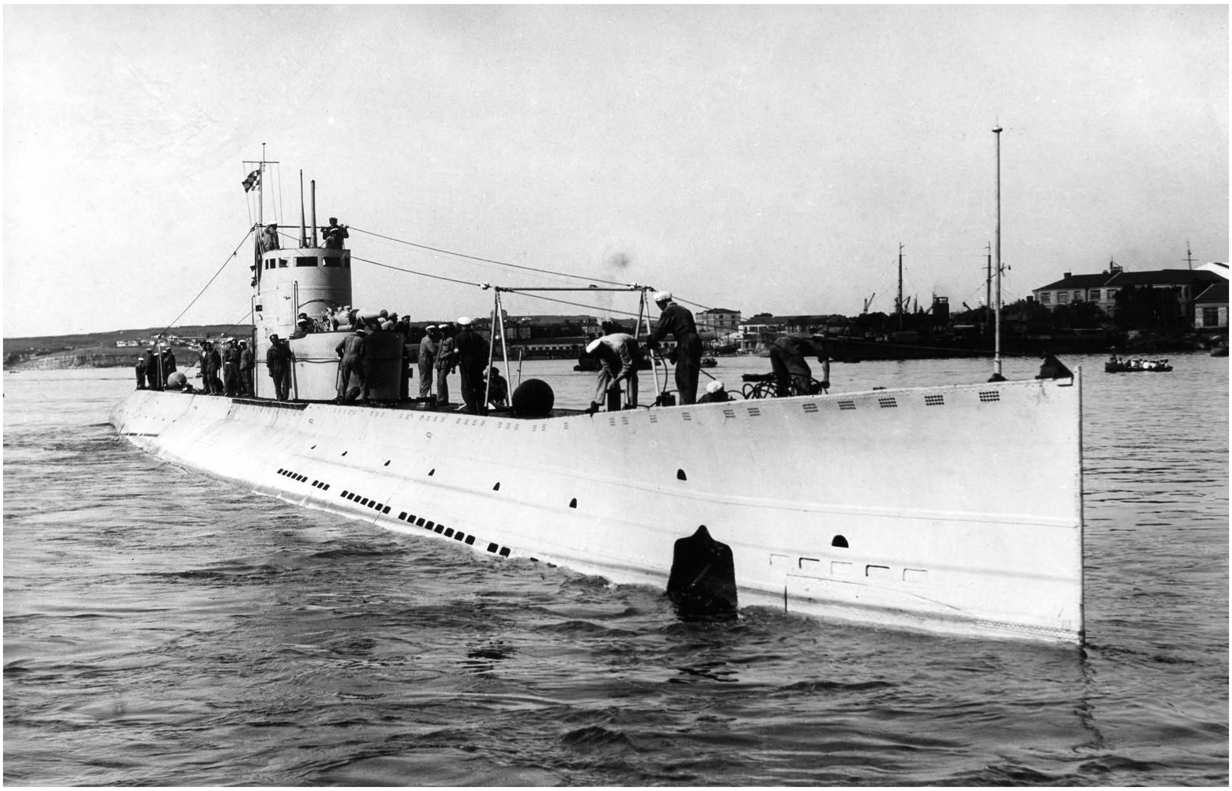
Series III (‘Shch’ Class): Section Cross section of Series III at frame 45, looking forward. The Admiralty saddle tank hull construction is in evidence.

- The vents for the port and starboard tanks were likewise separated.
- A total of 10 tonnes of excessive weight was removed.
- Seven buoyancy tanks were installed within the bridge fairwater (not in the Black Sea boats, as the density of water there was greater than in the Baltic).
- Longitudinal bulkheads were fitted in the deck ballast tanks.

According to the later findings of Bazilevskii, the first two modifications alone would have been sufficient to remedy the problem, together with strict observance of the diving manual, which stipulated that all main ballast tanks should be flooded simultaneously. The initial 3-degree starboard heel of *Dekabrist* was undetected during trials because the inclinometer was adjusted when the boat was in the water and already listing. The initial list caused uneven ingress of water via the Kingston



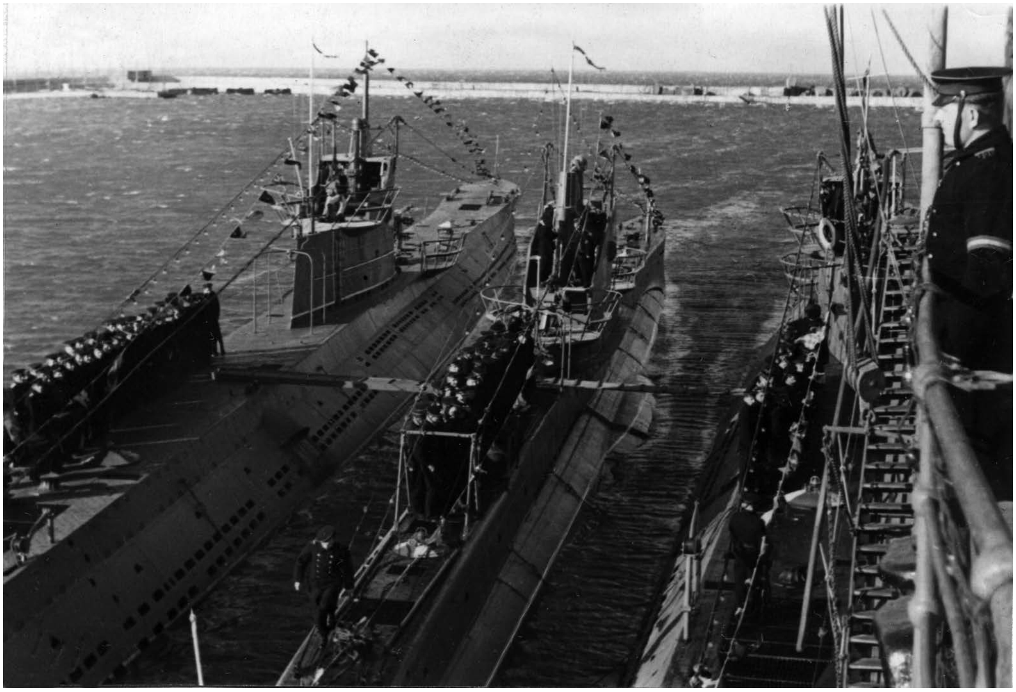
Three newly-commissioned Soviet submarines paid a visit to Istambul between 18 and 21 October 1933. Turkey was Russia’s main naval rival in the Black Sea, so this visit by the first true combat warships built since the First World War was a demonstration of power. *Revoliutsioner* is the first in the line, followed by *Spartakovets* and *Iakobinets*. (Courtesy of Bibliothek für Zeitgeschichte)



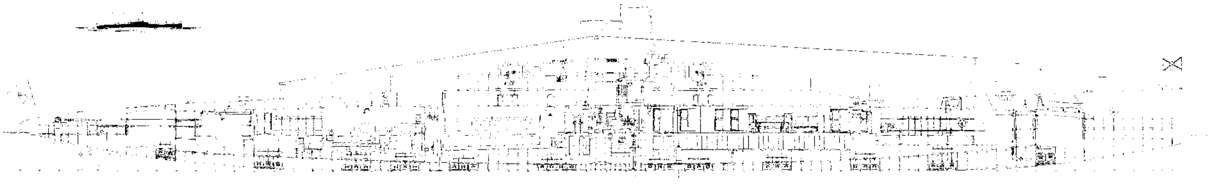
Garibaldiets returning from trials in 1933. (Boris Lemachko collection)

valves, and the situation was aggravated by the free-flood water surfaces – flooding of two pairs of tanks only out of six was insufficient to submerge the boat enough to completely fill the tanks. The same thing happened in 1933 during diving trials of *Garibaldiets*, the first of the Black Sea Series II boats. The embarkation of pig iron to counter the initial list proved to be sufficient to cure the problem.

It took little more than a month to introduce the changes on the most advanced boat, *Revoliutsioner*, and diving trials – begun on 5 September 1930 in the Black Sea – were successful. Before the end of 1930 the Navy



From left to right: *B 35* (formerly *L 1 Leninets*), *S 201* (formerly *Shch 201* of the Series V-*bis*) and *B 34* (formerly *L 4 Garibaldiets*) moored alongside the submarine depot ship *Neva* at Tuapse during the mid-1950s. Note the difference of size between the two types, and the extent of the modifications to the bridge as compared with the 'as fitted' configuration. (Authors' collection)



Series IV ('P' Class): Inboard Profile
Inboard profile of the Series IV design of 1930.

accepted her as well as *Dekabrist*, but this was the result of personal pressure from Muklevich, as both boats were a long way from being operational. Muklevich was keen to distract the attention of OGPU from the ailing programme of submarine construction. Their acceptance was officially and ceremoniously announced, but it took another year to eliminate the majority of defects and construction errors.

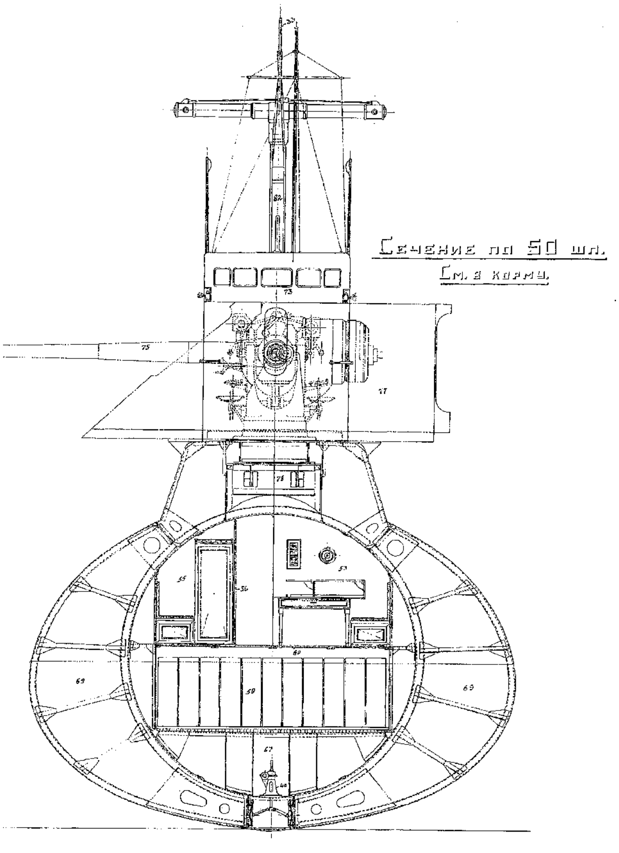
In the meantime, Malinin's stability calculation method was checked by carrying out the stability computation for *L 55*, which was known to be able to dive without a problem. The result of the calculations resulted in a negative metacentric height of minus 30cm with all main ballast tanks flooded. However, this indicated that the method was too demanding and would produce an excessively stable boat, thereby adding to the general confusion.

The next opportunity to verify the validity of the data arose in October 1930. Following the signing of a trade agreement with Italy, the Soviets gained an insight into the Italian submarine programme. Members of the Soviet naval mission were able to visit various submarines then under construction. The Russians paid special attention to the stability diagrams of the double-hull *Balilla* while the Italians, who were pushing for military contracts, were happy to give detailed explanations. Stability during diving had been discussed in detail at that time, giving the Russians, who were still stumbling in the dark, invaluable knowledge.

The White Elephants of OGPU

The 'wreckers' were assigned to an elite labour camp known as 'OTB EKU PP OGPU v LV' – the informal name given to such places was '*sharashka*'. This was the design and construction bureau of OGPU, in closed and guarded accommodation within the Baltic Works. They were subordinated to Aleksei Asafov, a submarine constructor who had been in jail since 1928. Like Malinin, he had some practical experience of submarine construction, but no theoretical knowledge at all. In an apparent attempt to secure an improvement in his personal situation, he lobbied for the construction of a 24-knot fleet submarine, inspired by the British 'K' class but with diesel engines. The idea of a fast submarine pursuing capitalist battleships appears to have been sufficiently 'revolutionary' and progressive to attract the attention of the OGPU apparatchiks. Thanks to their considerable influence and inter-service rivalry the idea took root, and in May 1930 the Staff of the Red Army duly issued a tactical draft for a 'fleet submarine'. This was approved by the *Revvoensovet* a month later and the submarines designated Series IV. Muklevich, who saw an opportunity to escape the attention of OGPU, put up little resistance, thereby paving the way for the project.

The arrest of Malinin and his colleagues suited OGPU; they were now able to put together an experienced team to pursue the fleet submarine project. However, the experience of the personnel was largely wasted, as they were tasked with executing workshop drawings only, without the right to raise objections or to criticise the principles of the design. The fleet submarine therefore constituted a step backwards, especially when the flawed tactical

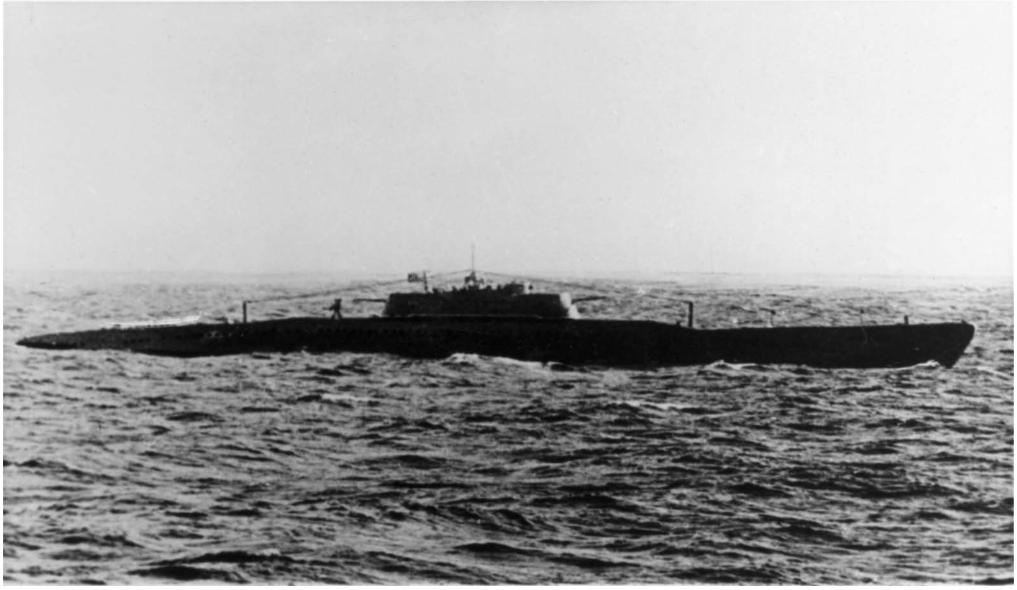


Series IV ('P' Class): Section
Cross-section of the Series IV design at frame 50 looking aft. Note the enormous 130mm gun housing, the double hull, and the battery, which as in Series II was an open compartment covered with planking.

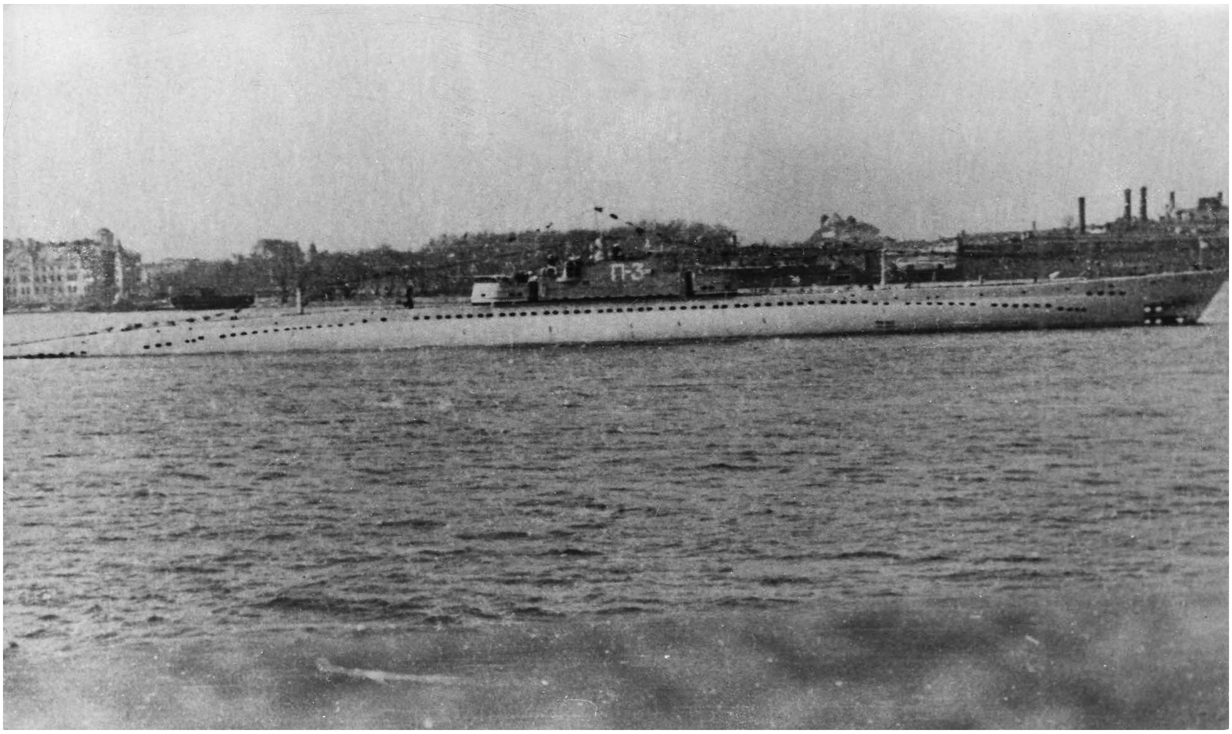
A wartime photograph of a Series II submarine entering the harbour at Poti in the Black Sea. (Boris Lemachko collection)

thinking and the lack of practical experience of Asafov was taken into account. Nevertheless, he was given full access to the *L 55* documentation, and was therefore able to incorporate features he understood.

The 900-tonne submarine, reported to have been copied from Bubnov's 1916 design, was of the double-hull type. The pressure hull was calculated for a design depth of 45 metres with external stiffening, and was divided into seven compartments by flat bulkheads. There were trim tanks at both ends, but no rapid-dive tank. The outer casing had the hull lines of a torpedo boat; it extended the whole length of the boat, and had a distinctive straight stem, a flared bow and a raised casing amidships. The two-shaft diesel/electric machinery was powered on the surface by two main and one auxiliary diesel engines, and was designed for a maximum speed of 24.3 knots with a two-hour overload. The main storage batteries were located in a single compartment closed



Pravda as commissioned in July 1936 following the first modifications: note the raked stem and the 100mm B-24 type guns with smaller shields. Internally the most significant modification was the removal of the auxiliary generator. (Courtesy of Bibliothek für Zeitgeschichte)



P 3 (*Iskra*, ex-*Iskrovets*) photographed on the Neva River in the late summer or autumn of 1940 in her final configuration, following her reconstruction December 1937 – September 1939. The hull casing was straightened and the gun shields removed. Despite all these efforts the three boats of the Series IV never achieved first-line status. (Boris Lemachko collection)

with planking and linoleum. Apart from the striking silhouette, the most impressive feature was a main gun armament of two 130mm guns in semi-enclosed mountings fore and aft of the bridge fairwater. Despite their battleship killer role, the submarines had only four reloads for their four bow and two stern torpedo tubes. The prototype, named *Pravdovets* (later changed to *Pravda*), was laid down at the Baltic Works in May 1931.

The Rebuilt *L 55* Runs Her Trials

The wheels of Soviet justice turned slowly, but they ground exceedingly fine. In April 1931 Malinin, Kriuger and Ruberovskii were judged, found guilty of 'wreckage' and sentenced to death by firing squad. The court, instructed by OGPU, amended the death sentence to ten years' imprisonment, while Bazilevskii got 'only' five years. In practice that meant that they had to remain confined to a *sharashka*. Submarine design and the supervision of construction was again reorganised as OKTB-2 by combining the OGPU *sharashka* at the Baltic Works with the former TB-4; the designers, both prisoners and free men, worked together under the leadership of Asafov. The background to this strange decision was growing criticism of the Series IV project within TB-4.

In July 1931 the rebuilt *L 55* went to sea and made 14 knots on the surface during trials, which was far less than the *Jane's* figure of 17 knots that had so impressed the Russians. The result was comparable with the performance of *Dekabrist*, which by this time had recovered from her 'teething' troubles. If one takes into account the successful resolution of the diving issues, the information on the stability of the Italian *Balilla* and the problems experienced with Flamm's U-cruisers, the verdict of 'wreckage' is cast in an entirely new light.

Not without significance was the fact that the new *Namorsi* Vladimir Orlov, in contrast to his predecessor, had practical naval experience before taking the top command role. Another factor was the increasing doubt surrounding the concept of the fleet submarine of Asafov. In January 1932 Malinin was put in charge of OKTB-2, and following his release (but not acquittal) in May 1932, together with Kriuger, joined the new design bureau TsKBS-2, which was out of OGPU's reach.

These developments reveal that Soviet justice had strong pragmatic foundations – the Naval Forces had already laid down an additional dozen submarines in the interim, and release undoubtedly provided better motivation for the naval architects than further punishment. They could be re-arrested at any moment without new formal charges and, like every Soviet citizen, were given no opportunity to leave the country without formal permission from the authorities.

Bazilevskii was kept in confinement (design bureau OKB-196) until 1933. At that time he participated in work on a theoretical model of submarine stability, which in practical terms focused on finding a solution that ensured double-hull submarines could submerge without capsizing – perceived at that time as the key success factor for the growing submarine programme.

Bazilevskii was released (but not acquitted) only following full static tests of *Dekabrist* that proved the validity of his model.

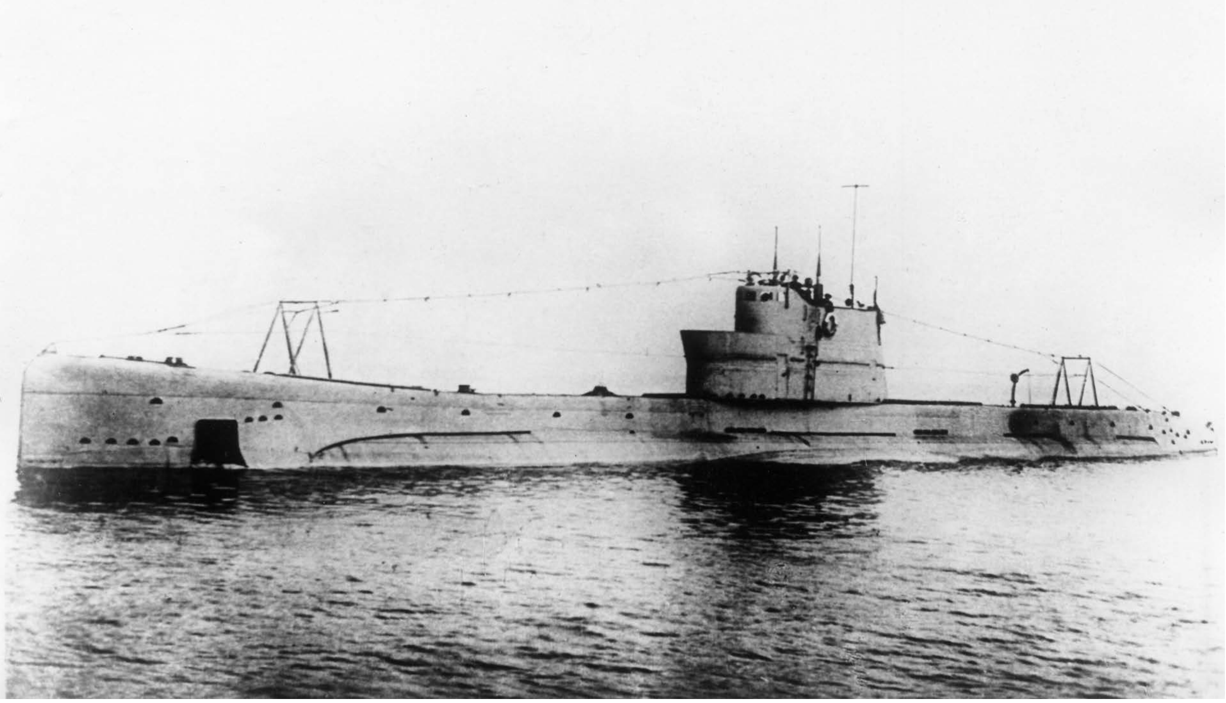
One of the first moves of the constructors following their release was a formal challenge to the *Pravda* class project that resulted in a suspension of construction. This was to be resumed in the autumn of 1933, but to a much-revised design that suppressed some of its most impressive but impractical features. The concept and original design were deemed to be a complete failure; by comparison, the shortcomings of *Dekabrist* could be considered negligible. The OGPU-born project could not be classed as 'wreckage', so Asafov remained in post; however, fear of another arrest caused a fatal heart attack – or pushed him to suicide according to other sources – in February 1933.

Conclusions

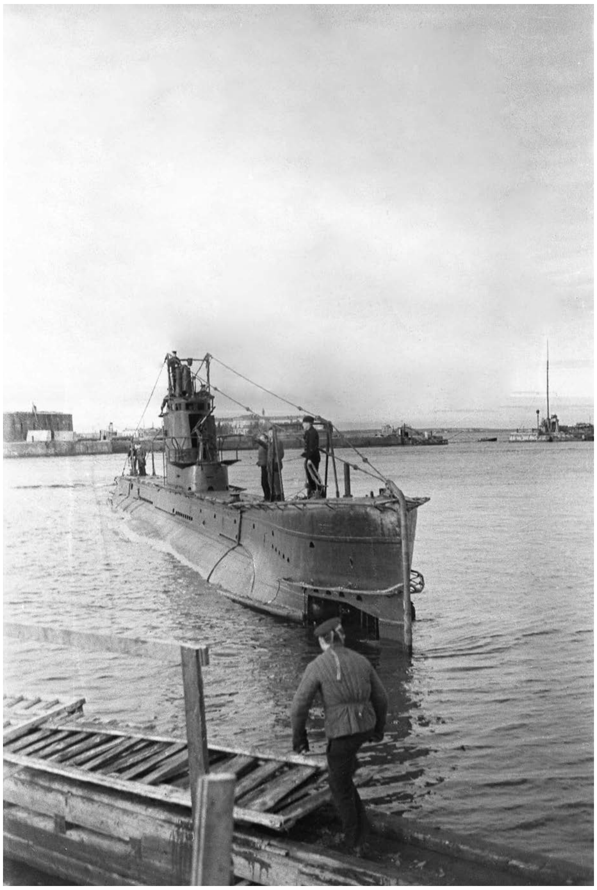
Dekabrist (Series I) became operational in March 1933 following a painful series of trials that tested her crew to the limit. Construction of the class was not continued beyond the units already authorised. The submarines saw operational service during the Second World War and achieved some successes. *Leninets* (Series II) and *Shchuka* (Series III) initiated the most numerous and successful developments in their category, and construction of follow-on types was continued until 1946. *Pravda* and her two sisters (Series IV) were accepted in 1936, apparently to avoid scandal, only to be taken in hand for refitting one year later. Their war activity was reduced to the transport role in 1941. Of the individuals mentioned only Bazilevskii, Krylov, Malinin, Shcheglov and Voroshilov died in their beds; the others lost their lives during 1937–43, being shot, murdered or dying in prison.

The historical assessment of *L 55*'s influence on Soviet design practice and technology has been ambivalent: on the one hand the Soviets were proud to secure such a prize, on the other their self-esteem suffered because of the evident obsolescence of their earlier practice. The assessment has see-sawed over time, beginning with enthusiastic statements by Voroshilov in 1929, through the absolute denial of any value by the submarine constructor Trusov (author of the report of *Dekabrist*'s diving trials) in 1988, and ending with the more balanced view of contemporary Russian writers.

As usual the truth is somewhere between. By 1929 *L 55* was no longer the last word in submarine design, neither from a tactical nor from a technical point of view. However, for the Russians, who after 1908 had been left behind by the submarine development mainstream and had lost almost everything ten years later, it was an enormous leap to bring them back into the submarine business. The magnitude of the task is evident if one considers that their only knowledge bank in the late 1920s comprised the workshop drawings of the dated *Bars* class and a few theoretical textbooks. *L 55* influenced not only submarine construction but also the Soviet military industry, and helped to boost the development of torpedoes, periscopes, batteries and electrical systems. It is indicative of the primitive, undeveloped nature of Soviet industry that the replacement of British equipment by locally-manufactured components when *L 55* was rebuilt increased displacement by 50 tonnes.



Shchuka during trials in 1933. She has a solid bulwark around the gun platform but lacks the planned 37mm 11-K AA gun. (Authors' collection)



Shch 303 Ersh during the war with a 45mm 21-K AA gun on a platform with a guardrail; the bridge has been modified to accommodate the gun. Construction of the gun was based on the 19-K type antitank semi-automatic gun, which itself was an enlarged copy of the Rheinmetall 37 mm purchased from the *Reichswehr* in early 1930s. The gun entered series production in 1934 and became the standard AA weapon of the Soviet Navy before the war. (Authors' collection)

Thus, when in 1932 the Soviet Union gained much wider access to German submarine technology, its naval architects had a much better understanding of the key issues.

Editor's Note:

The designation of weapons in this article, particularly guns and torpedoes, follows contemporary Soviet naval practice. The metric system was officially adopted by the Soviet Union in 1918, but was not implemented by the Navy until 1 January 1926. As a general rule, weapons developed in Russia prior to this date continued to use imperial measurements in their official designation, and imperial units were still being commonly used in the early 1930s. In the case of imported weapons, in Imperial Russia the designation reflected that of the country of origin (eg 450mm for torpedoes from Italy); this designation was retained under the Soviet Union.

In this wartime posed photo taken on board *Shch 303* the extent of modification to her bridge casing is apparent. The front of the bridge was inclined aft by one and a half frame spaces, which was necessary because the 45 mm gun was much longer than the 37 mm originally planned. (Authors' collection)

Acknowledgements:

The Editor wished to thank Steve McLaughlin for reading through the original draft of this article and advising on some of the Soviet institutions mentioned in the article.

All the drawings (except the one from Bazilevskii) are copies of the original shipyard drawings, held by the Russian Central Naval Museum and published in the works of Miroslav Morozov and Konstatin Kulagin. They were adapted for publication by Tomasz Grotnik.

THE DEVELOPMENT OF THE SMALL CRUISER IN THE IMPERIAL GERMAN NAVY (Part I)

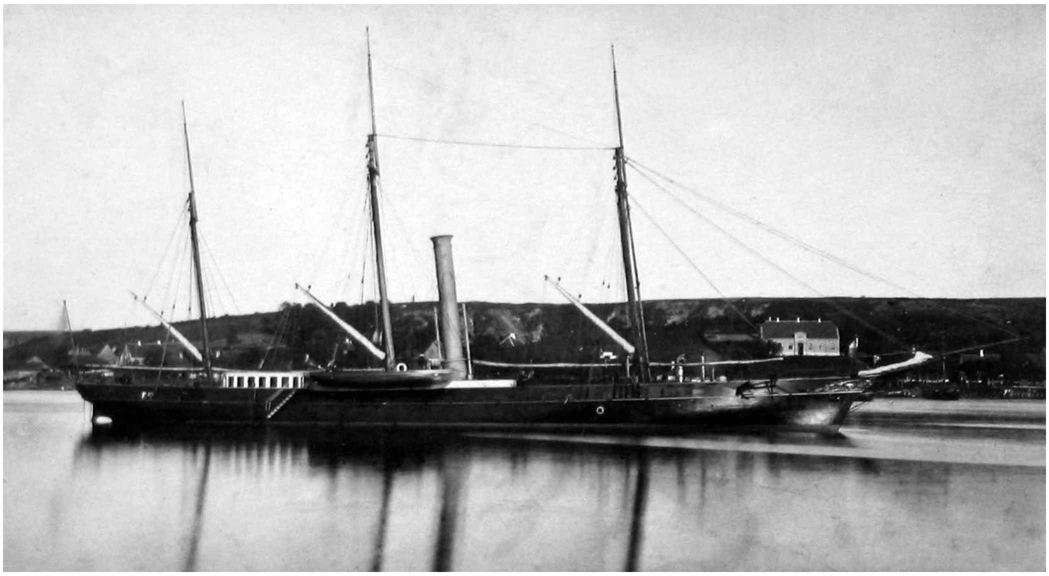
A design history of the development of the German *Kleiner Kreuzer* ('small cruiser') remains one of the significant gaps in the literature. In the first of a series of planned articles, **Dirk Nottelmann** attempts to shed some light on the first generation of these vessels, ending with the *Kolberg* class and focusing on key elements in the design of the type.

The story of the small cruiser in the Imperial German Navy (IGN) is by no means straightforward, and the various influences along the way resulted in vessels not ideally suited to any particular task. Fundamentally, their design was a merger of two separate lines of development that emerged from the early history of the German Navy, of which neither was to become truly dominant until shortly before the outbreak of the Great War.

The first of these lines may be traced as far back as the introduction of the so-called 'aviso' in the preceding Prussian Navy at the beginning of the 1860s. According to a contemporary German definition, an aviso was to be a 'fast vessel for reconnaissance, repetition of signals and delivery of orders within a fleet'. The unique *Grille* of 1857 is an early example. She had been built in France with a view to being used as a royal yacht, but had been employed in her second intended role as a scout during the Prusso–Danish War of 1864 and the Franco–North-German War of 1870–71. She was broken up only in 1920, after performing a variety of roles over the years.

More significant were two vessels constructed some 20 years later as the new imperial fleet took shape, based on an underlying plan developed in 1873 that had called for six avisos to be built during the following decade. These two ships, built by the Norddeutsche Schiffbau AG, Kiel, and the Imperial Dockyard, Wilhelmshaven respectively, eventually became *Blitz* and *Pfeil* when launched in 1882. Both received a schooner rig to complement their two-shaft machinery, but they proved to be poor sea-boats when under sail due to the drag of the twin screws. They were designed mainly for service in home waters and their steel hulls were not copper-sheathed against marine growth; they therefore needed to be docked frequently to preserve their maximum speed of 17 knots.

Their introduction into service established a policy in the IGN that any 'cruiser' designed to operate with the fleet should have at least a 2/3-knot margin over contemporary ironclads or ships-of-the-line. *Blitz* and *Pfeil* served the Navy well for some three decades, *Blitz* being



The aviso *Grille*, as built, moored in the Flensburg bight in 1864. Just visible in front of the mizzen mast is the deckhouse for 'distinguished persons'. (Author's collection) initially employed mainly as a flotilla leader for the new torpedo boat arm. *Pfeil*, on the other hand, initially deployed to east Africa to operate against the slave trade before returning home for her originally-intended duties with the fleet. Even after these two ships were replaced by modern small cruisers they were reclassified for further service.

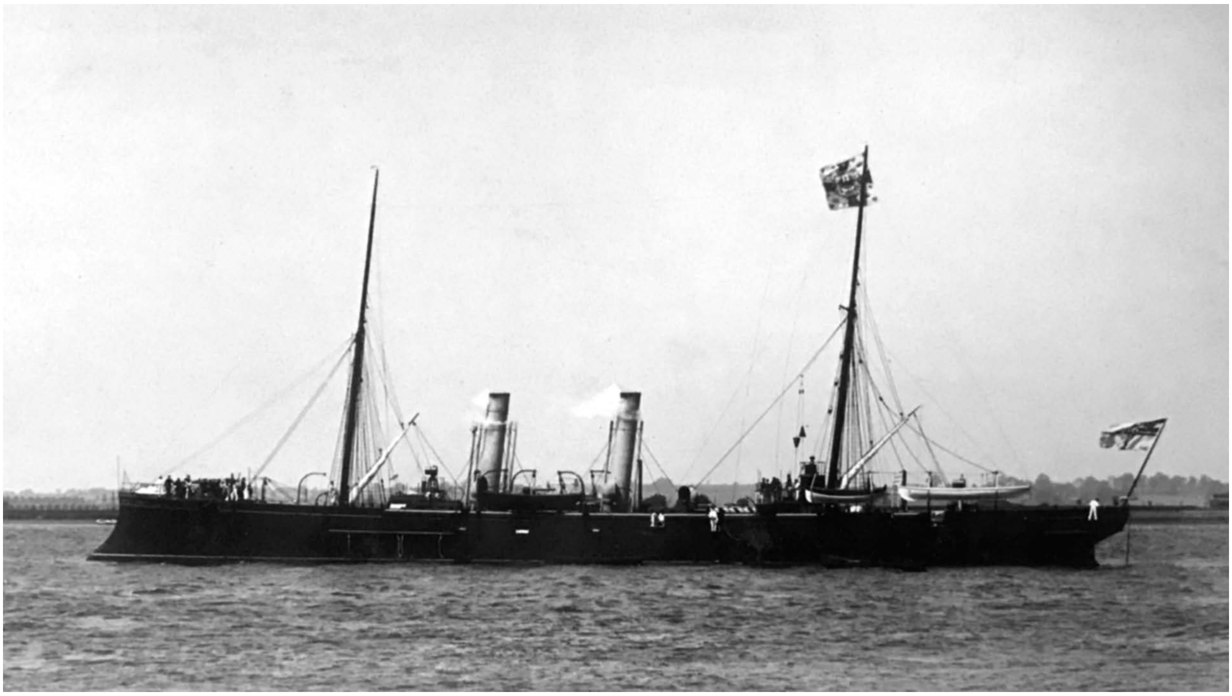
The second line of development emerged in the mid-1880s from a requirement for vessels to serve in, and protect trade to and from the newly acquired German protectorates and colonies. The task of operating in support of the still-modest German interests abroad had hitherto been assigned either to gunboats or, if a 'bigger stick' was required, a flying squadron of corvettes. From 1884 the term 'cruiser' was used in the IGN as a prefix, initially in conjunction with another term, either 'frigate' or 'corvette'. The designation was mainly directed at parliamentarians who were at the time reluctant to spend money on the Navy, particularly if funding was linked to the colonies – which were unpopular – or had no clear purpose; it therefore became associated with vessels serving abroad rather than those intended for home waters.

A Fork in Development

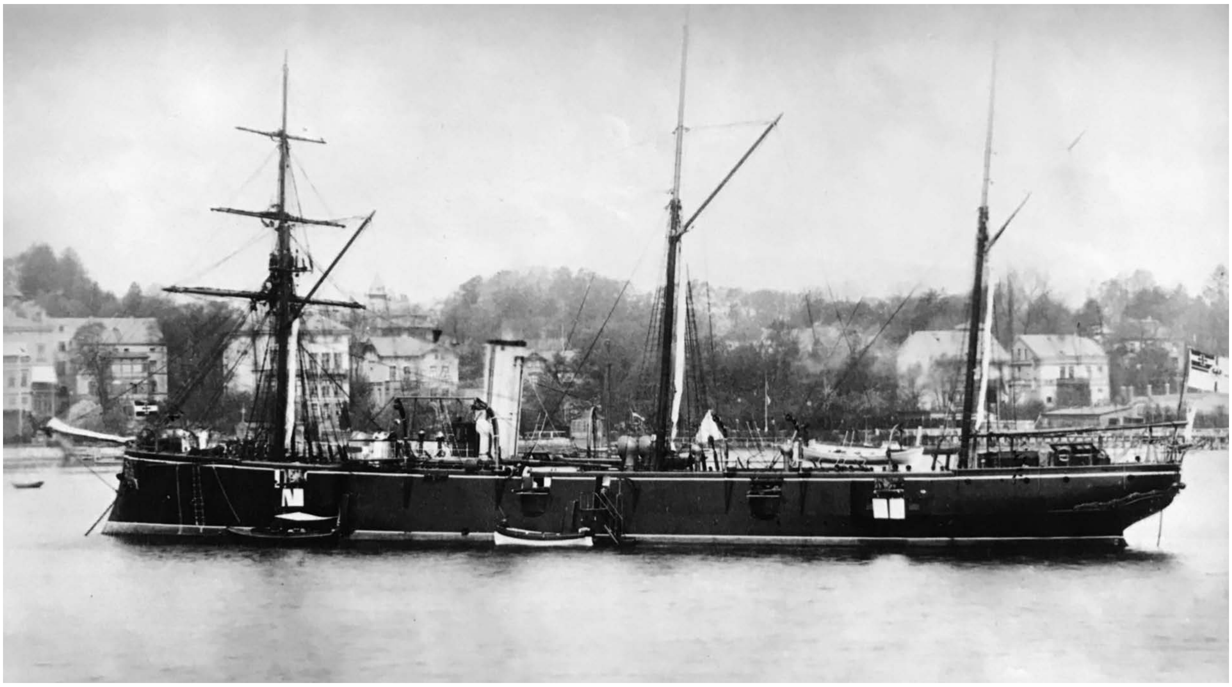
The estimates for the financial year 1886/87 included a request for two cruisers 'A' and 'B', without any qualification to the designation. These vessels would, at their launch, be named *Schwalbe* and *Sperber*, and in size they were not much larger than the most recent gunboats. They were the result of several contradictory requirements. On the one hand they were to serve for trade protection on the sea lanes, for which purpose the rig of a schooner-barque was installed, complemented by two-shaft machinery and copper sheathing of the hull; on the other, draught had to be sufficiently light for coastal or even riverine service. Their complement was to be sufficiently large – in contrast to that of a gunboat – to deploy a small expeditionary force for local police actions, and the initial main armament consisted of non-quick-firing guns (the last to be mounted in cruisers) plus a single torpedo tube, which could be trained and fired on both sides of the ship at a fixed angle.

Even the cost of vessels of their relatively small size seemed to overburden the annual allowance for the Navy in the eyes of parliamentarians, and *Sperber* would not be funded until the following fiscal year (1887/88).[1] In general the ships were a success, and paved the way for the larger and even more successful *Bussard* class. *Schwalbe* served for two periods either in southeast Africa or in China before returning home at the end of 1902 to be laid up. *Sperber* served longer, until 1911, in Africa, Micronesia, China and South America. They were ultimately broken up in 1920 and 1922 respectively. The six ships of the *Bussard* class, of about 900 tonnes displacement and with a main armament of eight 10.5cm QL guns, came to represent the standard German cruiser for service on overseas stations, the final unit (*Geier*) entering service in October 1895.

Meanwhile the aviso type for home waters went through a development of its own, first with ships which remained small or of moderate size, culminating in May 1896 with *Hela*, of about 2,100 tonnes displacement and



The aviso *Blitz* as lead-ship of a torpedo boat division visiting the Solent for Queen Victoria's Golden Jubilee Review in 1887. The large flag atop the main mast is indicative of the presence on board of Prince Wilhelm – one year later Kaiser Wilhelm II. (Author's collection)

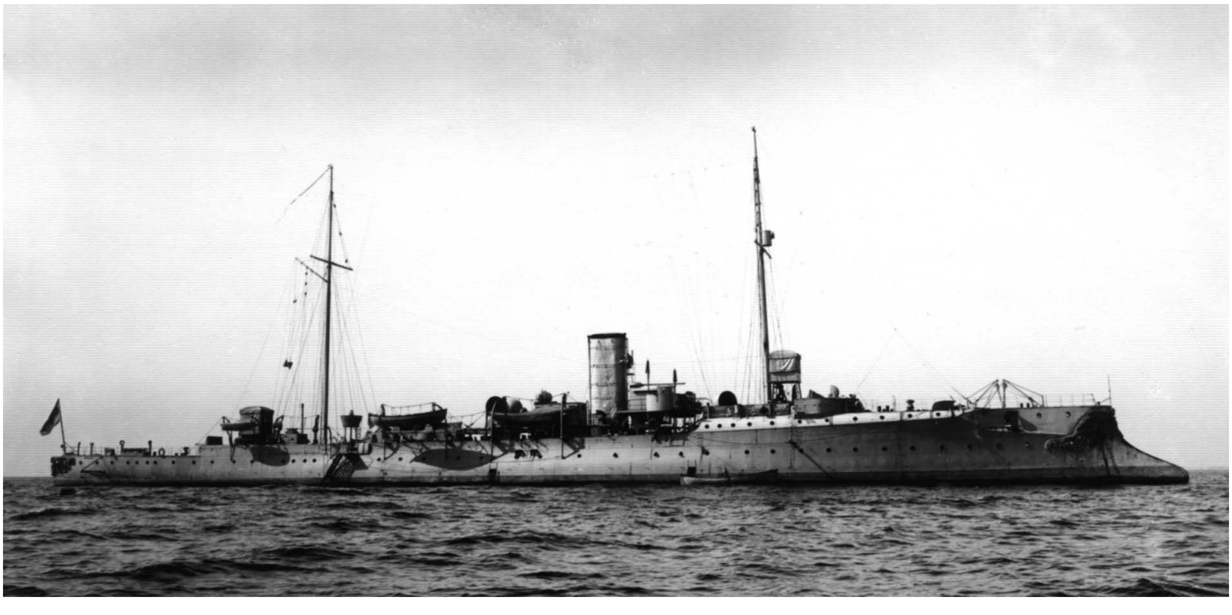


The 'cruiser' *Schwalbe* shortly after commissioning in Victorian livery at Kiel. Her diminutive size is readily apparent. (Author's collection)

with a main armament of four 8.8cm QL guns. The two fundamental differences between the two types would be speed – 20 knots for the aviso[2] as against only 15.5 knots for the *Bussard* class – and the fitting of an armoured deck to protect the machinery and the magazines. The first proposals that the two types should converge came in 1893, when the Supreme Command of the Navy (OKM) was asked by the *Reichs-Marine-Amt* (RMA – Imperial Navy Office) which improvement in the characteristics of (overseas) cruisers would be most desirable, and the OKM responded with a request for a significant increase in speed.

A New Direction

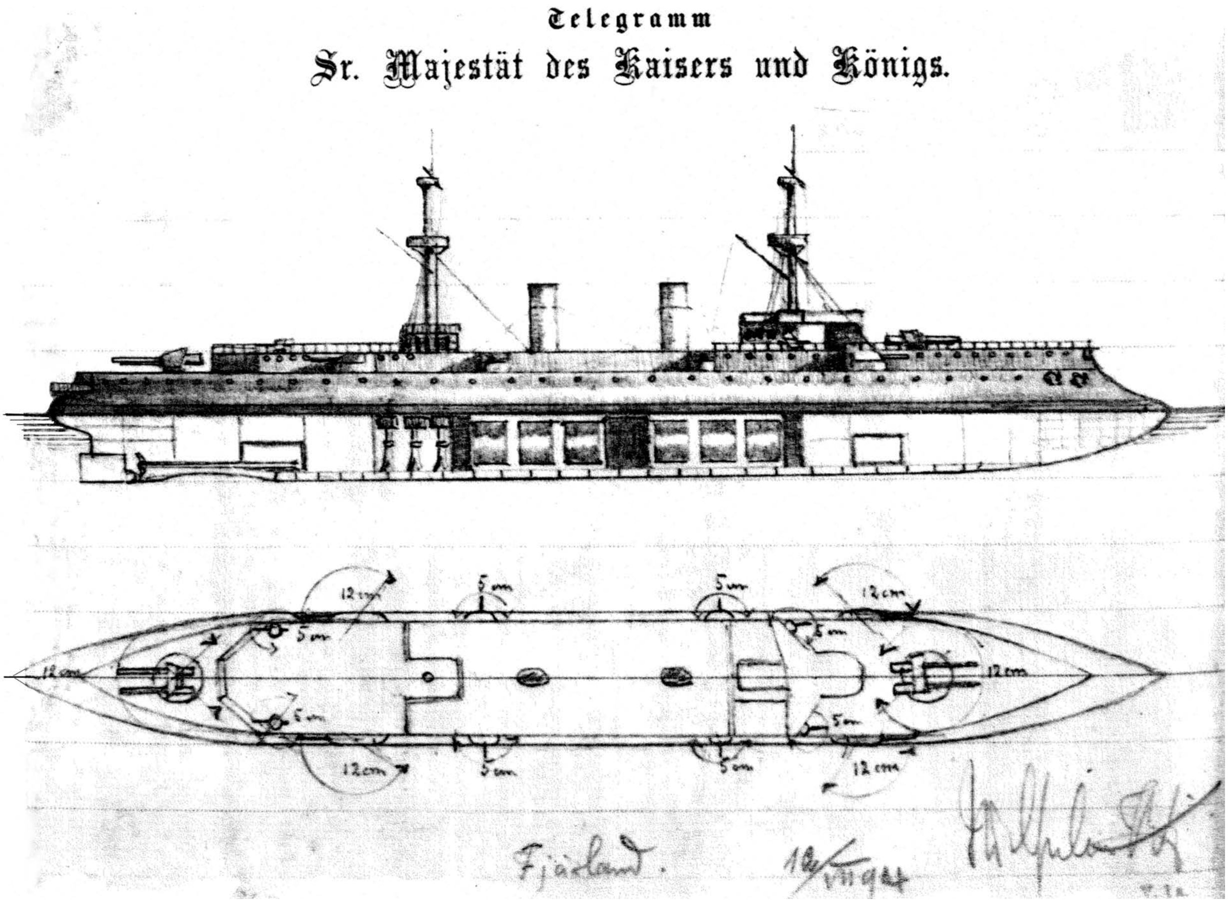
By this time, Parliament had again become increasingly unwilling to spend funds on the Navy, while the head of the RMA and *de facto* Navy Minister, Vice Admiral



The aviso *Hela*, last of her type and larger than the contemporary 'cruisers', is seen here shortly after commissioning. (Author's collection)

Friedrich Hollmann, had become notorious for his requests for *either* battleships *or* cruisers, or for an undefined mix of both. Against this background, the definitive merging of the two types of cruising vessel came as the result of an internal paper prepared in June 1894 by the OKM's chief of staff entitled, innocuously, 'General lessons learned from the manoeuvres of the autumn training fleet'. Its author was none other than Captain Alfred Tirpitz, who with this key document laid the foundation for his ascent to the post of Navy Minister, with a dramatic impact not only on the German Navy but on European history. The thoughts and reflections outlined in this paper were the only well-founded concepts to be found among the pool of vague ideas and options regarding the future of the Navy prevailing at that time, some of which originated with the Kaiser himself. Tirpitz's ideas regarding the future shape of the fleet and the use of small cruisers were summarised in his paper as follows:

> Speed has to be at least such that the small cruiser will be able to break off from an engagement with a battleship. A top speed of 18 to 19 knots at least will be desirable, to be maintained for several hours but not necessarily indefinitely. It would even enable the small cruiser to hunt successfully for the newest type of torpedo craft on the open seas and to conduct joint operations with large cruisers.
>
> A sufficient coal bunker capacity is deemed to be absolutely mandatory, because the consumption during scouting operations is generally excessive and – even if the supply by colliers for the main fleet is assured – the often-detached scouts will encounter more difficult and rare opportunities to fill their bunkers. Only a comparatively large amount of coal would enable the vessels likewise to be used on foreign stations, which seems most desirable. A true endurance (not merely a calculation made on the basis of trials) of 5,000nm at 10 knots is required.
>
> The cruiser's fighting ability must be such that she is able to successfully engage hostile scouts of comparable size, and several III. class cruisers should be able to take on a single large cruiser; the cruiser should also be a dangerous adversary for hostile torpedo boats. Requiring the small cruiser to be either equal in speed or even faster than a modern large cruiser, or be able to enter a fight single-handedly against a large cruiser cannot be achieved unless



This sketch is the first and (probably) only visualisation of Tirpitz's thoughts regarding an ideal III. class cruiser. It was drawn by the Kaiser during his annual summer cruise in Norwegian waters, which took place less than a month after the publication of the OKM paper. (Author's collection)

> the small cruiser is developed to the extreme in a single aspect, which would render her unusable for normal fleet duties. Nevertheless, it should be required that she carry effective weapons for shorter and longer ranges so that several small cruisers acting together will be able to put up an effective resistance to a single large cruiser. The small cruiser thus requires, besides a torpedo armament, a numerous and effective medium-calibre artillery.
>
> The ability of the cruiser to move and to keep afloat has to be ensured by an armoured deck and a suitable form of hull design so that she will not be lost unless most of the unprotected mounted guns have been disabled and the cruiser thus left unable to continue the fight. It is therefore unjustifiable to mount more dead weight for defensive purposes, which could be done only at the expense of other capabilities of the vessel.
>
> The cruiser requires two complete and independent command posts of which the forward one should be protected by a lightly armoured tower against the effect of machine guns, projectiles up to 5cm calibre, and shell splinters.
>
> The cruiser has to be a good sea-boat, so that even during longer voyages in open waters the performance of the crew will not be diminished significantly while under normal stress conditions.
>
> Masts should be of sufficient height to permit either the installation of large semaphores or shapes designed to be used for signalling at long distances.
>
> … One can assume with a certain degree of confidence that a displacement of 2,500 to 3,000 tonnes should be sufficient to fulfil the above-mentioned requirements for a III. class cruiser.[3]

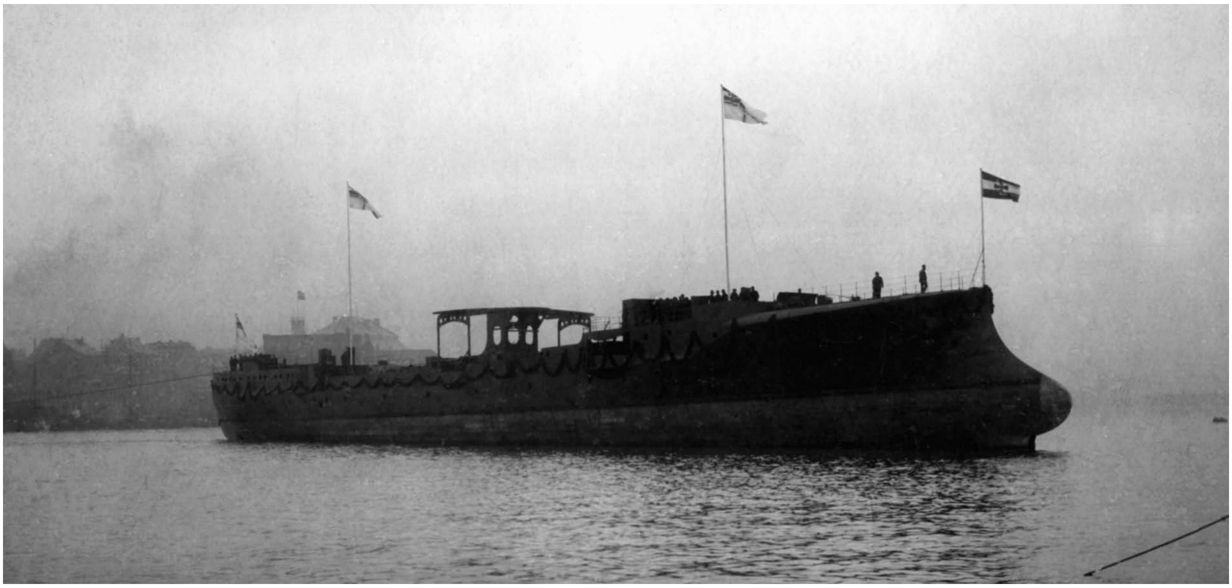
Without too much reading between the lines, it seems clear that Tirpitz was focusing almost entirely on vessels for fleet work. Foreign stations never played a significant role in his thoughts, as they would drain resources from the expected main theatre of war. Only the proposed endurance of 5,000nm suggests vessels useful for work overseas: however, this would never be Tirpitz's preference. Another point of interest is the references to 'III. class cruisers' which needs to be explained, given that nearly every navy had its own system of classification at that time. Under an imperial decree dated 29 August 1893[4] German vessels were to be classified as follows:

III. class cruisers: Vessels carrying a main armament of 15cm or below with an armoured deck.
IV. class cruisers: Vessels displacing more than 1,000 tonnes carrying a main armament of 15cm or below without an armoured deck.
Gunboats: Displacement below 1,000 tonnes.
Avisos: [No specifications at all – DN][5]

As will be seen, this classification system did not survive for long, and was amended during the design process for the new cruisers.

The Feud Between the OKM and the RMA

Unfortunately for the OKM and its protagonists this institution had, after the dissolution of the former Admiralty by the Kaiser in 1889, become responsible mainly for strategic and tactical questions, leaving the



Gazelle is launched in particularly gloomy weather on 31 March 1898 from the slipways of the Germania shipyard at Kiel. She was unique in having her conning tower (and charthouse) situated amidships in order to give a better all-round view in battle, although an additional navigation bridge was to be erected in front of the forefunnel. At the stem the single bow torpedo tube is just visible. (Author's collection)

Table 1: **A Comparison of Early German Small Cruiser Types**

	IV. class cruiser (old)	III. class cruiser (Tirpitz)	*Hela*	'G'
Displacement	1,918t	2,500–3,000t	2,082t	2,963t
Length oa	84m	(unspecified)	105m	105m
Beam (max)	10.6m	(unspecified)	11.0m	12.2m
Draught (aft/fwd)	4.92/3.92m	(unspecified)	4.5m	5.35/4.84m
Speed (max)	15.5kts	18–19kts	20kts	19.5kts
Endurance	3,610nm	5,000nm	3,000nm	3,570nm
Armament (main)	eight 10.5cm	eight 12cm	four 8.8cm	ten 10.5cm
Protective deck	none	(unspecified)	25mm	50mm

responsibility for the design and construction of vessels to the newly-founded RMA. And to the dismay of all involved, there was an internal feud between these institutions which preceded and resembled the notorious feud between the Royal Navy Admirals Fisher and Beresford some ten years later. Tirpitz's role in this conflict is interesting, as he first had to represent the aims of the OKM before becoming head of the RMA and subsequently working – successfully in the end – for the dissolution of the OKM. Due to this enduring feud, Tirpitz's expressed proposals or requests when he was head of the OKM were often intentionally overlooked or rejected outright by the RMA under the leadership of Vice Admiral Hollmann, whom he would eventually succeed.

On 10 May 1895 the General Department within the RMA presented the initial proposals for new construction during the fiscal year 1896/97. They included a request for a 'IV. class cruiser' designated 'G' which was intended as a logical follow-on to the IV. class cruiser 'F', which would be named *Geier* at her launch in October 1894. Not so logical, however, was a short remark in the files by Hollmann regarding the design of the new cruiser. On 18 May 1895 he wrote:

> Regarding the IV. class cruiser 'G' I request that the design, according to my instructions given earlier, should be of a scheme with an armoured deck broadly similar to the aviso *Hela*.[6]

This was actually the birth of the *Gazelle* class but it was nevertheless a surprise in more than one sense, and an indication of Hollmann's notorious inconsistency of direction. Unfortunately, this note lacks any further explanatory comment. The question arises as to how he planned to explain the necessity of a vessel of such an unusual type to the delegates in Parliament. Would it operate with the fleet or serve on foreign stations? Additionally, according to the current classification, this would be a true III. class cruiser, a type that had been vehemently rejected by Hollmann during previous discussions with the OKM.

Surprisingly, none of the delegates questioned the type and its specifications during the subsequent annual sessions of Parliament which began in the autumn of 1895. This may be due to the fact that the 1895/96 imperial tax revenue had been higher than never before, meaning that a degree of extra spending on the Navy became possible and was thus ultimately granted. However, this was not the end of the confusion: bizarrely, one year later – for the fiscal year 1897/98 – another aviso was included in the budgetary request under the designation 'Ersatz-*Falke*' ['Replacement for *Falke*', an old paddlewheeler and makeshift aviso in use since 1870 – not to be confused with the recent IV. class cruiser of the name]. Both vessels – 'G' and 'Ersatz-*Falke*' – had identical specifications and were linked together in the accompanying tabular display of requests with the same explanatory remark: 'To be built as III. class cruisers.'(!) In the end, however, the 'Ersatz-*Falke*' failed to secure authorisation during the debates for fiscal year 1897/98, which ultimately would be one of the reasons for the downfall of Hollmann and his subsequent replacement by Tirpitz.

The key specifications for the projected IV. class cruiser, which would become the starting point for all subsequent German small cruisers, are outlined in the accompanying table, which provides a comparison with earlier ships.

Initially, 'G' (to be launched as *Gazelle*) would have had an appearance close to her predecessors, although it is difficult to be certain as the three early drafts of the projects have not survived. What is known, however, is that the vessel was originally to have been fitted with four Scotch boilers and a differently shaped stem, without provision for a bow torpedo-tube. Either way, it is clear that 'G' mirrored Tirpitz's proposal quite closely but exceeded the displacement of both her predecessors by a large margin whereas, in keeping with the class designation, the main armament was limited to the 10.5cm calibre, which would set an unfortunate precedent for the future (see below). Tirpitz was fully aware of this: his views as expressed in 1894 show that he would have preferred the 15cm gun, provided this did not mean that the number of mountings was too small, given the limited displacement:

> A straight reduction in gun calibre from 15cm to 10.5cm would appear unwise even for III. class cruisers, because the latter gun does not possess sufficient penetrative power against armour, and the explosive effect of its shells is insufficient to ensure success in a fight against cruisers of other nations, which are generally equipped

> with heavier calibres. … To fulfil the requirements under section 3, a main armament of eight 12cm or 12.7cm is deemed necessary …[7]

With the exception of gun calibre and the reduction in endurance, the project closely resembled Tirpitz's proposal. These particular aspects would soon prompt a further heated exchange between the OKM and the RMA, which was ultimately pacified only by a personal intervention from the Kaiser. The struggle offers a rare insight into the underlying thoughts of chief designer Alfred Dietrich, who rarely spoke out of turn. In a paper dated 24 June1897, when 'G' had already been laid down (April), the OKM requested some modifications to follow-on vessels, which were now to be designated 'small cruisers'.

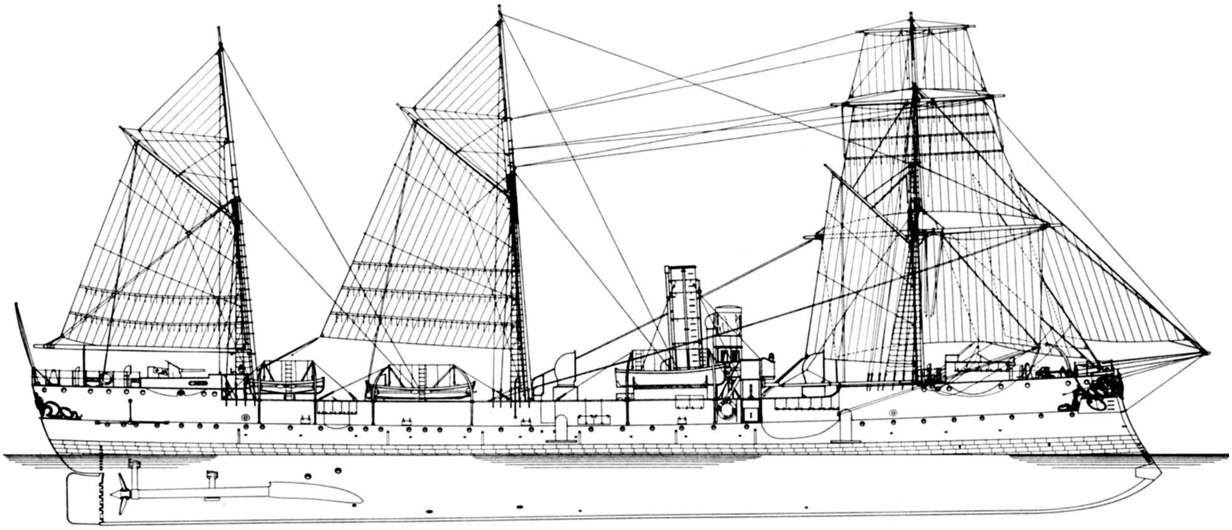
The First Fleet Law

Since the preparation of his memorandum of 1894, which would form the basis of the later so-called First Fleet Law, Tirpitz had realised, during the subsequent debates in Parliament, that a key to obtaining approval from the delegates would be the clarity of designations – an area in which Hollmann had conspicuously failed. Consequently Tirpitz, with the approval of the Kaiser, had reduced their number to three: 'battleships', 'large cruisers' and 'small cruisers'. These would be the major types the parliamentarians would have to deal with in the future. With hindsight one might see that this amalgamation of the various categories of vessel was inevitable, but in the event it took place only once Tirpitz was appointed to head the RMA.

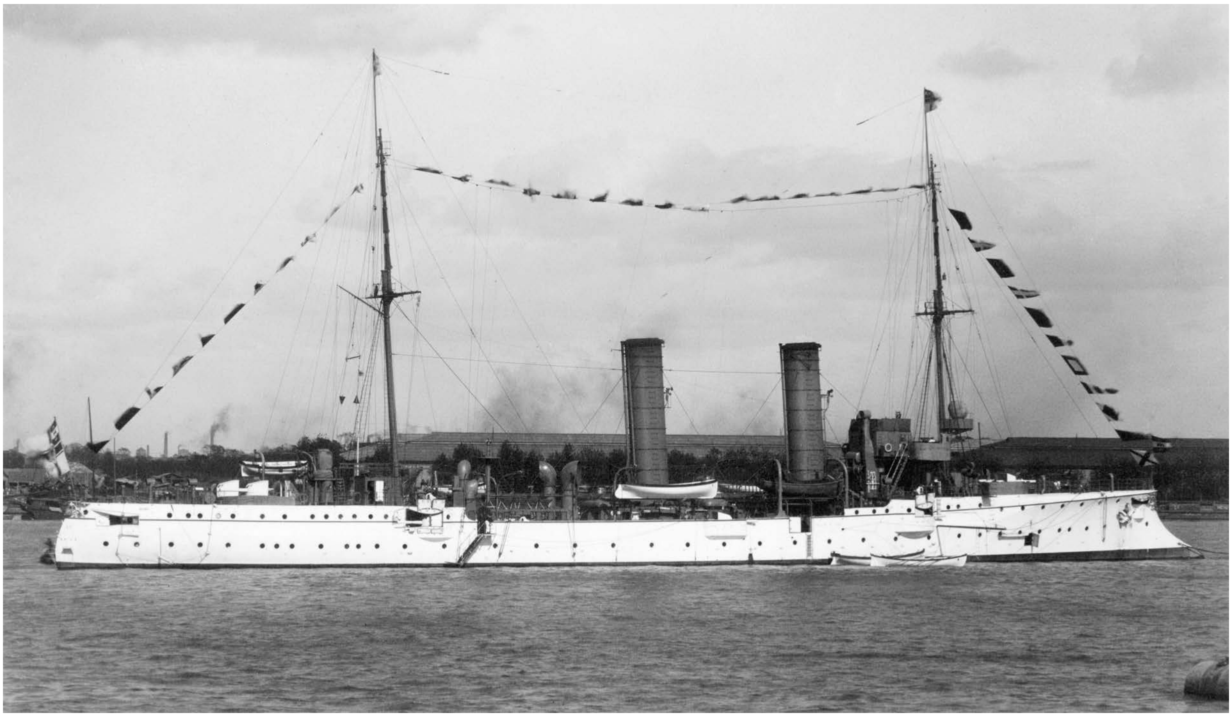
In the 24 June paper the OKM requested (*inter alia*) that, in future, designed speed should be raised to 21 knots for a three-hour period, as the battleships of the *Kaiser Friedrich III* class had already been designed for a three-hour maximum speed of 18 knots. Another aspect of focus was an increase in endurance – as yet unspecified, since nobody yet knew how efficiently the newly-introduced watertube boilers would perform. Finally, an increase in the calibre and number of the main guns seemed desirable. The OKM expected that incorporating these features would probably result in an increase in displacement to 4,000 tonnes – a figure which nevertheless seemed acceptable. Any future cruiser design would have to take these requirements into account.

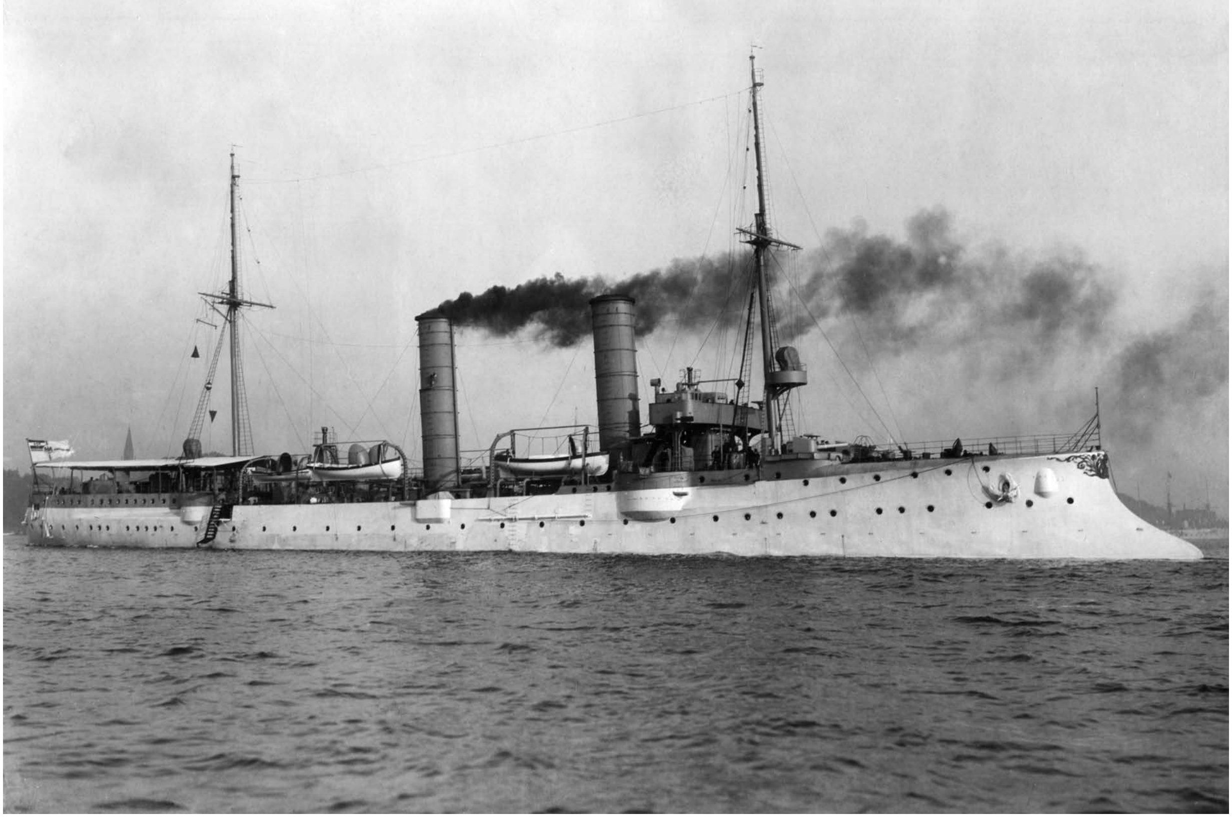
Dietrich responded about one month later that, according to his calculations, a vessel of 3,000 tonnes would indeed be too small for the desired improvements. These would require a ship with a displacement close to 3,400 tonnes and an overall length of 112m; cost would exceed that of 'G' by 26% or 1.18 million Marks.[8] This evaluation effectively stymied the OKM's requests: the General Department argued that the greater length would result in inferior tactical capabilities, but the major problem, in the context of the Fleet Law being prepared in parallel and its unpredictable reception by Parliament, was the increased cost. The financial calculations presented to the delegates with respect to the required total of 30 small cruisers had been based on the 4.6m-Mark estimate for 'G', which left little leeway for changes to the design. However, this outcome did not satisfy the OKM, whose head of department, Admiral Eduard von Knorr, wrote a note of protest to Tirpitz:

> Cruiser 'G' has been opposed as inadequate by the OKM since its first appearance in 1894. I was anticipating a convergence of opinion between the two most eminent naval offices after the definition of the Naval Law, particularly as the views of the OKM have not changed since the days when Your Excellency was a member of this institution. … If Your Excellency is claiming … that these demands could only be fulfilled by raising the displacement by 800 tonnes



A line drawing of the IV. class cruiser *Condor*, a member of the *Bussard* class and the first naval vessel to be built by the renowned Blohm & Voss shipyard in Hamburg. (Drawing by the author)





The cruisers *Niobe* (upper photo) and *Nymphe* (lower). Although officially sisters, there were a number of significant differences, not all of which are visible to the naked eye. *Niobe* was equipped with Thornycroft boilers, whereas *Nymphe* introduced the new Schultz watertube model to IGN service. *Niobe* had wood and copper sheathing, *Nymphe* a bare steel hull. Both ships are seen here in the livery employed on foreign stations until 1910: *Niobe* is depicted somewhere in Chinese waters, *Nymphe* as escort to the Imperial yacht *Hohenzollern* in home waters. (Author's collection)

> and the cost by 1.2 million Marks, I can only state in return that in my view it would have been better to make these sacrifices instead of providing the Navy with a cruiser type of little utility.[9]

The note must have made an impression on Tirpitz, since three years previously he had himself employed similar arguments against the RMA, then led by Hollmann

In a further contribution to this debate, Rear Admiral Paul Hoffmann, former head of the East Asia Cruiser Division and the direct predecessor of Tirpitz during his short stint in this post before becoming head of the RMA, used his weight as an experienced leader of an overseas cruiser division to state:

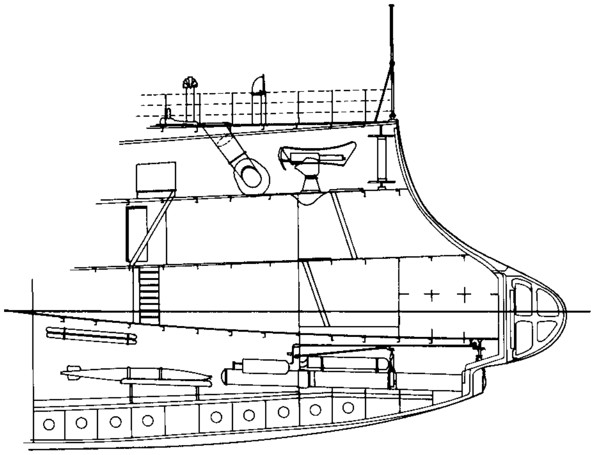
> A 3,000-tonne vessel armed with 10cm guns represents in reality not much more than an improved *Cormoran* [*Bussard* class – DN] which is, as you yourself have conceded, of inferior quality. ... If deployed on foreign stations a IV. class cruiser will not suffice because of the small number of men able to be sent ashore or because of the inferiority of her armament ... thus an armoured cruiser would have to be sent instead.[10]

In view of these (and other) statements which could clearly not be ignored, Tirpitz wisely assured himself of the backing of the Kaiser. Thus the new small cruiser would in general remain as originally planned, although small improvements would be worked in to pacify at least some of its critics.

The future cruisers 'A' and 'B'[11] were accordingly to be built very close to the standards set by 'G'. Both were ordered immediately after approval of the Fleet Law and laid down in August and November 1898 respectively. In one respect at least the objections of the OKM bore fruit: largely on the initiative of the Germania shipyard, one of the competitors in the bids to build the new vessels, the maximum output of the engines was raised from 6,000ihp to 8,000ihp without impacting on the dimensions of the machinery spaces, resulting in a designed speed of 21.5 knots for both. The specification of cruiser 'B' (*Niobe* – built by AG Weser) remained a little closer to 'G', with the adoption of eight Thornycroft instead of Niclausse boilers – resulting in a similar narrower spacing of the funnels – as well as the wood/copper sheathing of the hull. Cruiser 'A' (*Nymphe* – built by Germaniawerft) would become the model for the later ships of the new type by introducing the Schulz water-tube boiler,[12] as well as a bare steel hull.

A Degree of Continuity

The further development of the small cruiser followed a comparatively smooth trajectory, with small incremental improvements up to the *Dresden* class of fiscal year 1906. According to the First Navy Law, two small cruisers were to be laid down annually, beginning in 1899; following the passing of the Second Fleet Law in 1900, the annual number rose to three until 1906 when it again dropped to two. The principal characteristic to be enhanced continuously from class to class was the design speed, which had become decoupled from the speed of contemporary battleships, being now linked to that of large cruisers. This was another indication for the preponderance of 'home based' naval thinking, because on foreign stations speed was certainly a subsidiary criterion to endurance, which remained more or less constant at around 4,000nm at economical speed until the *Magdeburg* class.



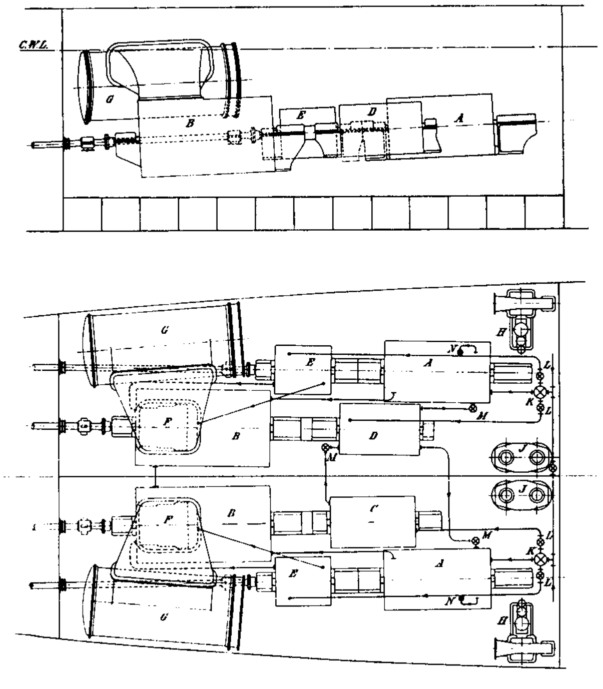
A cutaway drawing of *Gazelle*'s stem. The special design of the ram, with the single bow torpedo tube beneath, is evident. The mounting of a hawser reel at the forward end of the main deck is an indication of the limited space aboard the small cruisers. (Drawing by the author)

One particular military feature that did change from the construction of 'G' (*Gazelle*) to that of her successors was the ram bow. The original configuration adopted had a much less pronounced profile but, on the personal insistence of the Kaiser, this had to be changed to a shape explicitly similar to that of *Hela* and more in keeping with the 'French style'. *Gazelle* had been constructed with a prominent ram which could break apart along a pre-determined seam under excessive stress. It was strengthened by the mounting of a 45cm bow torpedo tube, which had long been common in the avisos. However, during the design of the follow-up vessels, Dietrich's successor – Dietrich had died on 6 September 1898 – at last dispensed with this dated feature because the supporting structure behind the ram could never be made strong enough for ramming within a lightly-built cruiser hull without accumulating excessive weight forward. For reasons of trim, the bow torpedo tube disappeared as well, never again to reappear. What remained initially was the concave line of the stem. Over the years there have been various attempts to explain this unusual configuration, *eg* as a fore-runner of the bulbous bow. This ill-informed conjecture is contradicted by the fact that on each subsequent class of cruisers the ram became less pronounced until it was finally completely abandoned with the *Magdeburg* class, without any obvious adverse effect on the resistance of the hull through the water. Interestingly, this process had been carried through more expeditiously in contemporary gunboats: experience gained during the sea trials of the new *Iltis*(ii), *Tiger*, lead vessel of the subsequent subgroup, led to the immediate adoption of a straight stem.

The Introduction of Turbines

What became of particular interest very soon – within the follow-on class from the *Gazelle* class – was the introduction of steam turbine propulsion. One cruiser of the fiscal year 1903 *tranche* – Ersatz-*Merkur* (*Lübeck*) – was chosen to become a test-bed.

The first turbines were installed on German vessels in 1901, but for driving electrical generators only. After acknowledging the progress made in the Royal Navy with the acquisition of the torpedo boat destroyers (TBD) *Viper* and *Cobra*, commissioned during 1900/01, Tirpitz, at the end of 1901, ordered the new head of construction department 'K', Vice Admiral Rudolf von Eickstedt,[13] to evaluate the possibilities for the use of turbines as main engines on German vessels, the incentive being the expectation of higher power output and speed for a given mass. However, it soon became evident that potential German suppliers of turbines were not yet in a position to meet requirements, thus a delegation from 'K' went to Great Britain in April 1902 for an information-gathering visit to a variety of manufacturers. It concluded that only turbines built by or licensed from the Parsons company could provide the required performance, and a contract was signed with Brown, Boveri & Co (BBC), as a subcontractor to the Deutsche Parsons Marine AG Turbinia, for the delivery of two sets of turbines. One was for the future torpedo boat *S 125*, to be built by the well-known Schichau shipyard at Elbing, and the other for the above-mentioned cruiser to be built at the equally renowned Vulcan shipyard at Stettin. Both ships were members of larger classes – *Lübeck* was the fourth unit of seven – so it was expected that there would be sufficient scope for comparison with the performances of their sister vessels.

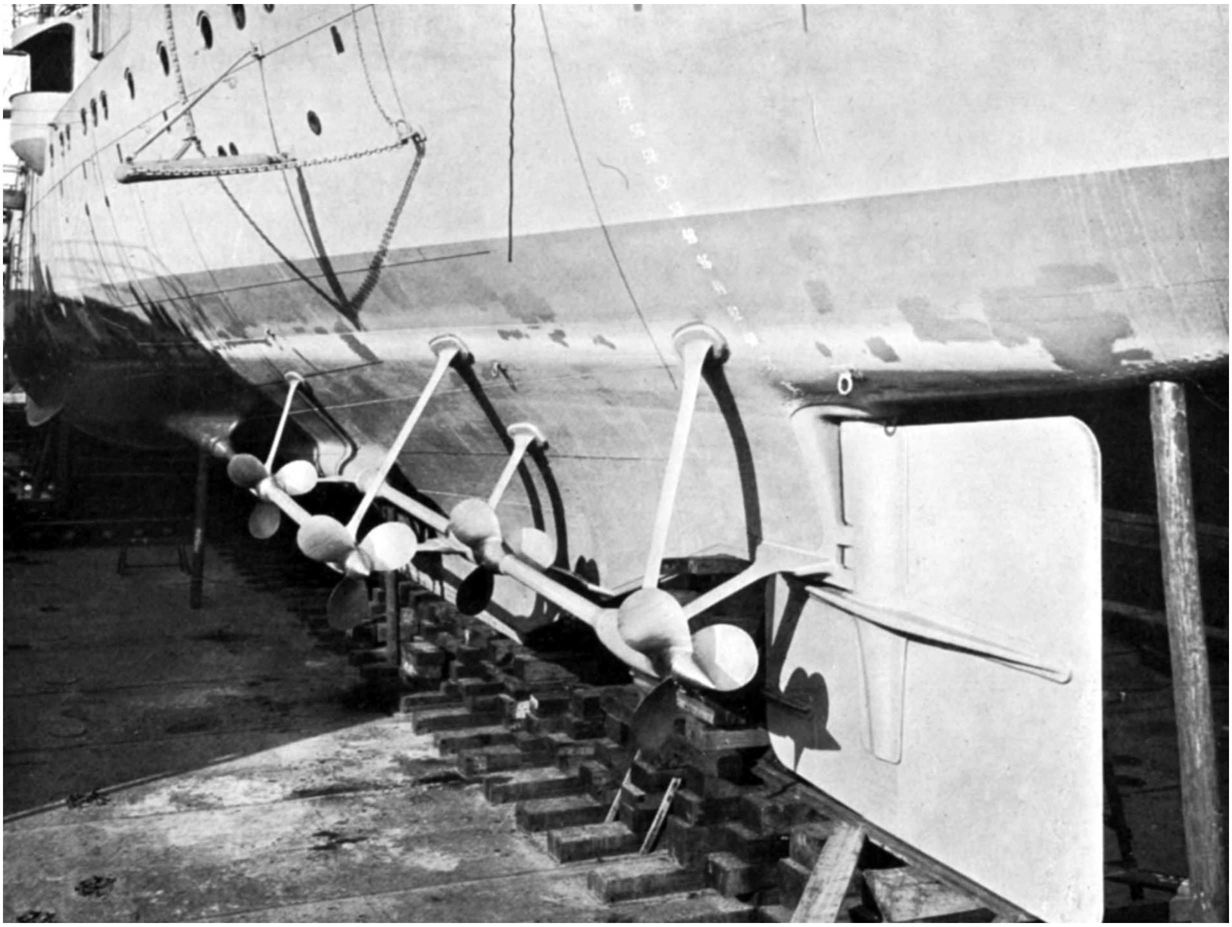


Schematic drawing of *Lübeck*'s turbine machinery: A – HP turbine, B – LP turbine, C – HP cruise turbine, D – LP cruise turbine, E – HP astern turbine, F – LP astern turbine, G – condensers, H – main cooling water pump, J – air pumps, K – main manoeuvring valves, L – manoeuvring valves, M – non-return valves, N – circulation valves. (Author's collection)

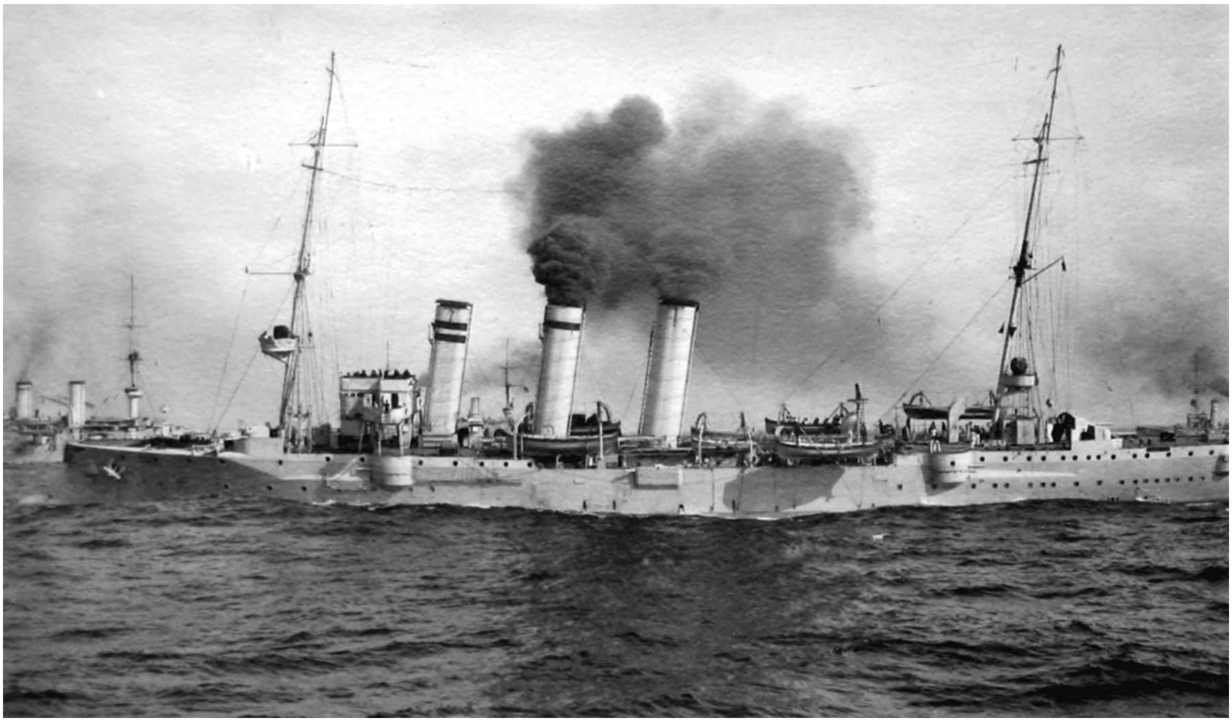
Wisely the RMA did not demand a higher design speed than the 22 knots of Ersatz-*Merkur*'s sister ships, even though the Turbinia concern was prepared to guarantee an output of 11,000shp instead of her sisters' 10,000ihp. From the outset the new plant was hampered by its novelty and complexity. In total ten individual turbines, including forward, astern and cruise turbines, served the four shafts. After the approval by the Kaiser (20 January 1903) to equip one of the 1903 cruisers with turbines, the official decree of construction gave the following general description of the plant's configuration:

> For the plant in general the decree of construction for machinery, boilers and fittings of the small cruiser 'M' [*München*] is binding, as far as no variations caused by the turbine machinery are concerned. …
>
> The turbine machinery will consist of two sets of symmetrically arranged turbine bodies, each comprising:
> - one high-pressure (HP) main turbine with a separate, coupled HP astern turbine;
> - one low-pressure (LP) main turbine with an LP astern turbine installed in the same casing before the exhaust outlet;
> - on the starboard side, one HP cruise turbine coupled to the LP shaft; on the port side one LP cruise turbine coupled to the other LP shaft. The main engines to work independently of each other, whereas the cruise turbines are interconnected.
>
> The four propellers on the port side turn to the left, the four on the starboard side to the right.[14]

Unsurprisingly, the manufacturing of the large cast components for the turbines fell behind schedule. Krupp, as main supplier, announced to BBC on 20 January 1904 the failure of several cast steel components for the rotors and their casings mainly because of the new alloys being trialled but also due to the general complexity of the installation. Laid down on 12 May 1903, *Lübeck* was launched on 26 March 1904 with a scheduled delivery date of 1 August 1904. This date came and went without the machinery being even close to delivery. Finally, on 18 March 1905, the acceptance trials could commence, and these ended with the ship's commissioning on 26 April 1905. However, the trials were far from complete: they were to be particularly exhaustive because of the new characteristics of the vessel and, for instance, included



Lübeck's four port-side propellers during fitting out. Their small diameter of only 1.372m is particularly evident. (Author's collection)



Lübeck operating with the High Seas Fleet during the annual manoeuvres of 1910. (Author's collection) direct competitive trials against *Lübeck*'s sister *Hamburg*; they were concluded only on 22 August 1906.

The results of these trials were far from conclusive regarding the efficiency of the turbines themselves and ship-handling characteristics. One major obstacle to direct comparability had been the impossibility of measuring the turbines' output. Rather than the commonly-used indicator devices employed for piston engines, turbines required torque meters for measuring their output, and these were still in their infancy at that time. Thus all statements regarding the efficiency of the propulsion machinery had to remain based on calculations and assumptions. Moreover, propellers of different configurations and in different numbers – ranging from four to eight identically-shaped propellers to eight with a different configuration – were tested. The trials revealed a major problem, namely that the high rate of shaft revolutions required for turbine efficiency degraded the efficiency of the propellers. The latter had a reduced blade area compared to those employed for reciprocating engines, and this meant that not only did the maximum speed on the measured mile not exceed that of *Lübeck*'s sister vessels – despite the (calculated) higher output – but coal consumption was significantly higher as well. The same could be said about the rates for stopping and acceleration, in which *Lübeck* was markedly inferior compared to her sisters.

However, these initial difficulties did not affect the RMA's long-term intention of introducing turbine propulsion into the IGN. Tirpitz has often been reproached for being over-cautious in the introduction of new technology, but – following the tradition of the former head of the Admiralty, General Leo von Caprivi – his prevailing view had always been that the German Navy could not accept the burden of failed experiments on a larger scale, so he usually proceeded in small incremental steps: he insisted that before installing turbines in one of the precious major vessels prolonged trials should be conducted with smaller vessels such as cruisers or torpedo boats. Even before *Lübeck* had commenced her trials in March 1905, one or two (eventually just one)[15] of the three cruisers of the 1905 estimates had been slated to receive turbine propulsion, followed by one of the two cruisers of the 1906 estimates. The major drawback was that Turbinia remained currently the only German company capable of turbine design and manufacture, so both these later vessels, which would be named *Stettin* and *Dresden*, had to be equipped with turbines of the Parsons type without the possibility of competition. Nevertheless, their performance improved markedly over *Lübeck*, and each of them in turn became the fastest German cruiser of the day. Both were intended to be capable of 24 knots during trials while actually achieving 25.2 knots at maximum power on the measured mile.

The characteristics of the new, turbine-powered ships are detailed in the accompanying table with *Undine*, the final unit of the *Nymphe* class, used for comparison. These data clearly illustrate that the constant enlargement of the light cruiser type had its sole foundation in the constant requests for higher speeds; all the other military characteristics, both offensive and defensive, remained the same except for the replacement of the 3.7cm Hotchkiss machine canon (MK)[16] by the more modern 5.2cm semi-automatic gun. The rationale for the introduction of the latter had been the increasing size of the hostile TBDs which might be encountered, on which even multiple hits of the smaller calibre no longer guaranteed the desired effect. On the larger units of the fleet the role of fending off the attacking destroyers by the standard 8.8cm quick-loader (QL),[17] which was not an option for a small cruiser with a main armament of 10.5cm guns, so the new 5.2cm model was exclusively designed for use on the small cruisers and – for a short while only – on the most recent torpedo boats. The Navy was never very happy with the gun despite its impressive rate of fire (up to 40 rounds per minute) because of its very limited effect on a target, and discarded it when it came to build the cruisers of the 1909 programme.

Another significant (external) feature is worthy of note: the change in profile between the 1904 *Königsberg*

Table 2: **Characteristics of the Early Turbine-powered Small Cruisers**
(*Undine* for comparison)

	Undine	***Lübeck***	***Stettin***	***Dresden***
Estimates	1901	1903	1905	1906
Displacement (max)	3,112t	3,661t	3,879t	4,268t
Length oa	105.0m	111.1m	117.4m	118.3m
Beam (max)	12.4m	13.3m	13.3m	13.5m
Draught (aft/fwd)	5.6/4.8m	5.5/5.5m	5.1/5.1m	5.5/5.5m
Engines	VTE	Parsons turbines	Parsons turbines	Parsons turbines
Horsepower (des)	8,000ihp	10,000shp	13,500shp	15,000shp
Boilers	9 w/tube (Schulz)	10 w/tube (Schulz)	11 w/tube	12 w/tube
Speed (desi)	21.5kts	22kts	24kts	24kts
Endurance	4,250nm	3,800nm	4,170nm	3,600nm
Armament	ten 10.5cm ten 3.7cm MK two 45cm TT	ten 10.5cm ten 3.7cm MK two 45cm TT	ten 10.5cm eight 5.2cm two 45cm TT	ten 10.5cm eight 5.2cm two 45cm TT
Protective deck	20/50mm	20/50mm	20/50mm	20/50mm

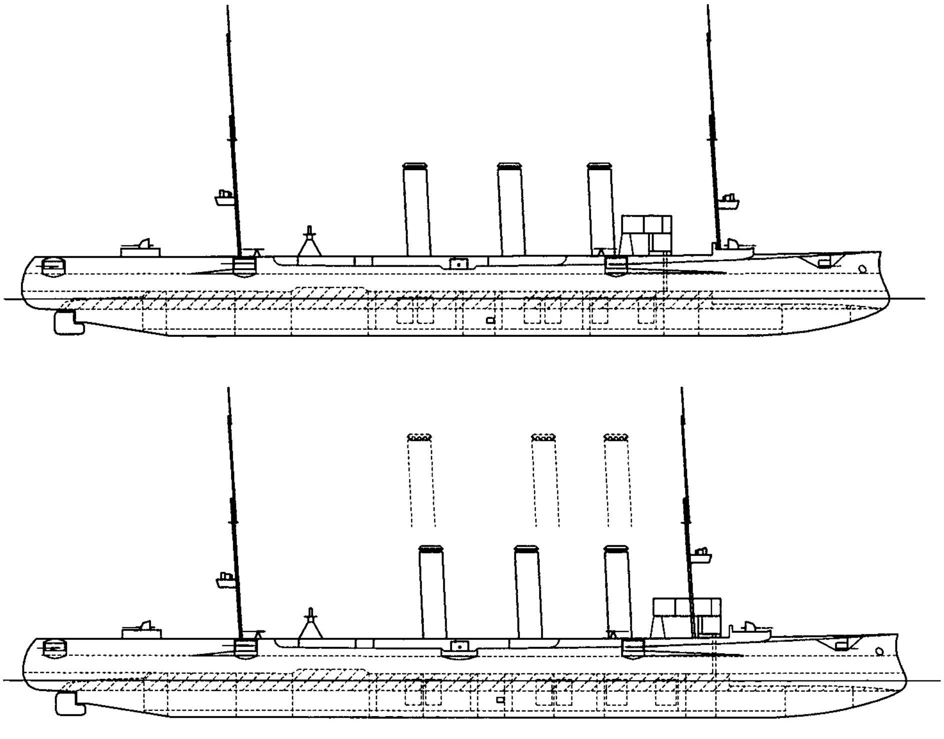
and the subsequent 1905 vessels *Nürnberg*, *Stettin* and *Stuttgart*. Originally all four were intended as members of the same class but, following a report by Tirpitz to the Kaiser in December 1904, it was decided to pay special attention to one of the critical lessons of the Russo-Japanese War: the need for protection against underwater threats. The two after boiler rooms in the 1904 cruiser were to be subdivided by two additional watertight bulkheads, thereby increasing the number of watertight compartments from 13 to 15. This required a redistribution of the ready-use coal bunkers and consequently the lengthening of the hull by two metres compared to *Königsberg*. Even more significant was the redistribution of the funnels. *Königsberg* had already been fitted with one more boiler compared to the preceding *Hamburg*/*Leipzig* classes. This single boiler was added to the foremost boiler room and displaced the neighbouring torpedo room, which was moved aft and located amidships, between boiler rooms 2 and 3. In order to retain the standard profile of three equally spaced funnels, it was initially accepted that the exhaust gases of the centre funnel would have to change direction sharply twice during their passage from the boiler through the uptakes to the funnel – a solution much disliked by the engineers. After the division of the centre boiler room in the 1905 cruisers by bulkheads carried up to the armoured deck things became even more complicated, and it was finally agreed that the centre funnel could be moved forward and the rear funnel farther aft, thereby securing an almost vertical upward flow of the exhaust gases for most of the boilers. Thus the 1905 cruisers came to be known in the IGN as those with the 'detached funnel'.

In the 1906 cruisers, *Dresden* and *Emden*, this arrangement was 'tidied up'. The addition of yet another boiler was achieved by moving the foremost boiler section aft, thus allowing the installation of two (smaller-sized) boilers side by side. The torpedo room had to be moved back to its former location, which meant that the command post and the navigation bridge also had to be moved forward, and were now located in front of the foremast. These measures eventually gave both vessels the most well-balanced look of all the older cruisers of the IGN.

The move to all-turbine propulsion was completed only with the cruisers of fiscal years 1907 and 1908. All four were fitted with turbines based on different principles and produced by different manufacturers – generally reflecting the shipyards in which the ships were built – for competitive comparison. One of the cruisers of the first batch (*Kolberg*) would receive a set of modified Parsons turbines manufactured by the new competitor Melms & Pfenniger (later known as the Schichau turbine) – the turbines under development by the Zoelly-Germania and the Schultz companies were insufficiently advanced. The other (*Mainz*) received for the first time a set of AEG-Curtis turbines, which were associated with the Vulcan shipyard. Of the second batch of 1908 cruisers, one (*Cöln*) would receive the now-mature Zoelly-Germania turbine but, as the Schultz type never materialised, the final ship (*Augsburg*) reverted to the original Parsons turbine.

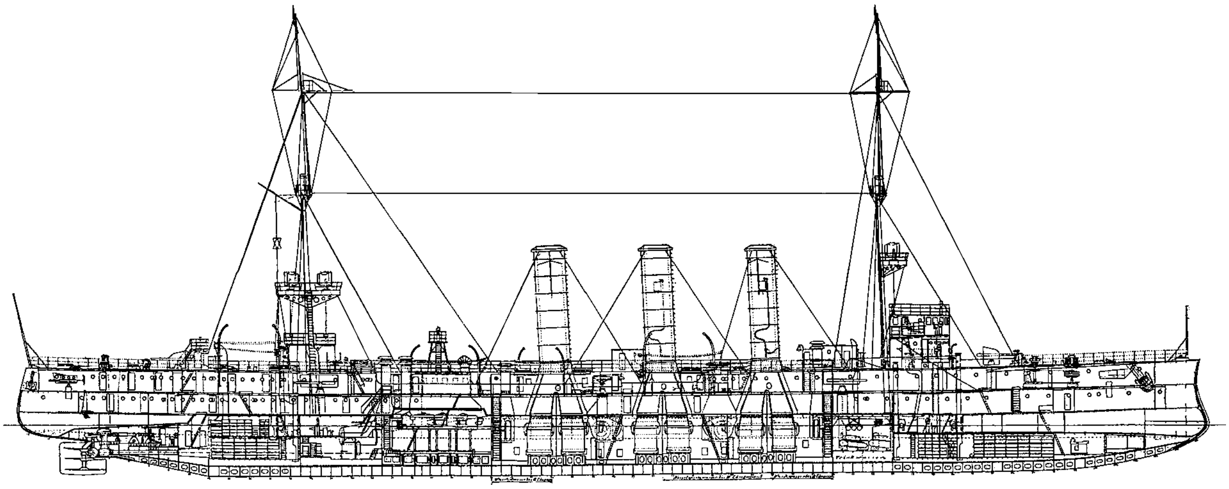
The *Kolberg* Class

The rationale for the 1907 type, later known as the *Kolberg* class, is explained in a rare statement from

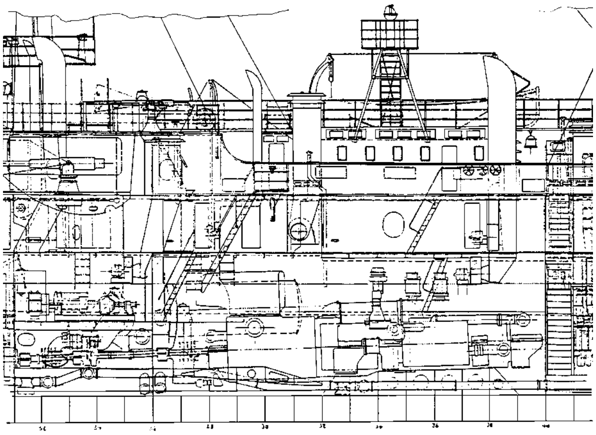


Two sketches showing the main differences between *Königsberg* and *Stuttgart*. The upper shows *Königsberg* in her initial form, with her bridge and mast still separated as in the *Hamburg* class; she was modified prior to her commissioning.

The lower shows the distribution of her boilers and the evenly-spaced funnels following the insertion of the extra bulkheads. The broken lines above show the final, optimised arrangement of the funnels. Drawing by the author)



The original sectional drawing of *Emden* (top) with a small midship section of *Dresden* below, showing the principal differences between the two sisters. In *Dresden*, weight was saved by the deletion of the armoured glacis necessitated by the cylinders of *Emden*'s vertical reciprocating engines. *Emden* was the last German cruiser to employ reciprocating-engines. (Author's collection)

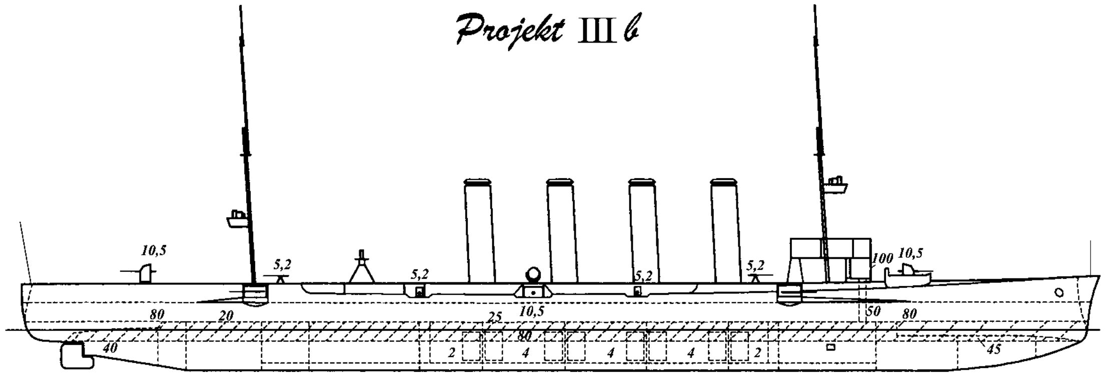


Admiral von Eickstedt which, due to its unusual level of detail, is quoted here:

> In [a memorandum regarding the design of the small cruisers of 1906 – DN] by 'A' dating from December 1905 it was stated as desirable that the speed of future designs should be raised to at least 25 knots. Meanwhile, the speed of large cruisers, foreign as well as our own, has increased markedly. This increase is so great that raising the small cruiser's speed only by the figure demanded by 'A' is thus no longer desirable; a figure greater than 25 knots appears to be essential. 'K' has tried to achieve this increase in speed by staying within the boundaries of the general conditions of construction as well as by keeping the displacement below 4,000 tonnes, which had the verbal approval of your Excellency. ... Compared to the 1906 cruisers these requirements will, nevertheless, require an enlargement of the boiler spaces and consequently of the displacement, together with a further lengthening of the vessels.
>
> ... The greater length not only results from the fact that the boiler rooms can generally be extended only longitudinally, but from the results of several test tank trials using models of different lengths. ... The new cruiser should attain a speed of about 25 knots during a 6-hour trial with forced power, and 25.5 knots during a full power run on the measured mile, compared to the 23.5–24 knots of the 1906 cruiser. ... With regard to the shape of the stem it is intended to dispense with the ram and replace it with a straight stem with a slight flare at its upper end – comparable to the British Scout Adventure – because this form is expected to provide the driest forecastle during the ship's pitching in conjunction with the largest deck area forward. If, because of the general outlook, this new form is not yet considered acceptable, one of the two 1907 vessels could be built with the older bow form for comparative purposes.[18]

The figures given here for maximum speed suggest that the propulsion machinery was designed for short bursts of 19,000shp, while the normal design output would be 17,500shp. According to German machinery design criteria this would have required the installation of at least fifteen boilers distributed between five boiler rooms, the exhaust gases to be vented through four funnels to minimise the reduction in draught. A similar proposal had already been studied for the twelve boilers of the 1906 cruisers but was eventually rejected. The same occurred with the new proposal: in the end, after a careful comparison of weights and boiler room lengths, a layout comprising four boiler rooms and three funnels was adopted.

For the first time, however, the main armament was also increased. Beginning with *Gazelle*, as we have seen, it had comprised ten 10.5cm L/40 quick-loading guns. This gun had been introduced in 1897 and was the first with axial recoil in place of the Vavasseur system, in which the gun recoiled up an incline and rolled back



A re-drawing of one of the proposals for arming the Ersatz-*Greif* class. Project IIIb would have retained the armament of the earlier cruisers, but with the enclosed bow and stern 5.2cm mountings moved to the upper deck amidships. Of even more interest is the proposed new configuration of the stem and stern and the move to four funnels. (Drawing by the author)

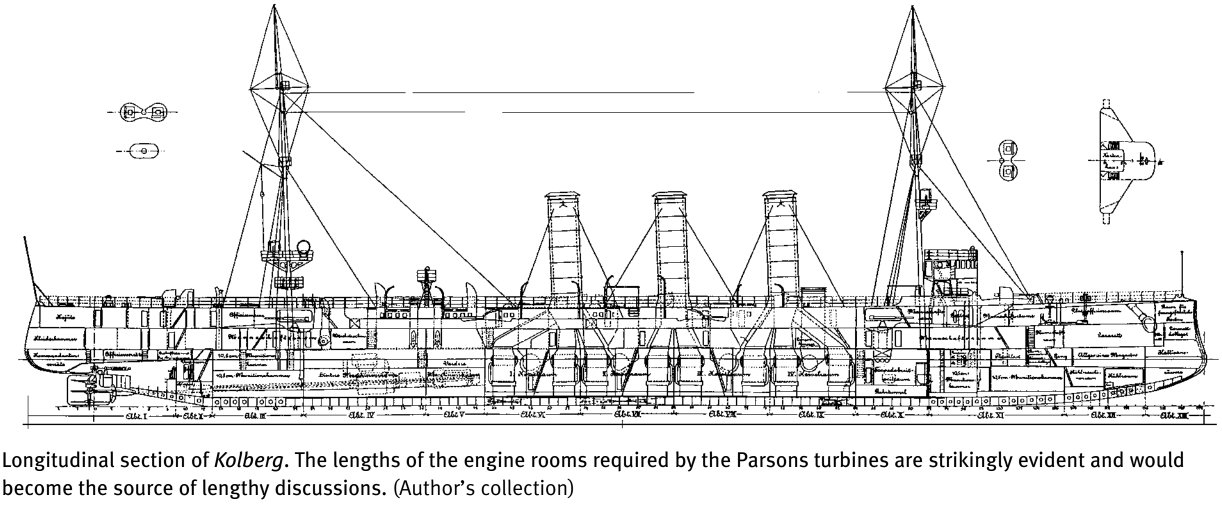
down to the firing position under its own weight. It was subsequently slightly modified, with the C/04 mounting introduced for the first time on *Lübeck*. The final improvement came with the introduction of the 10.5cm L/45 gun in a modernized C/06 mounting on the *Kolberg* class. It was felt – after a brief consideration of retaining the classical mixed armament in which the 10.5cm was complemented by a number of 5.2cm secondary guns – that the sheer size of the new vessels precluded the retention of this armament. Interestingly, however, the order of construction signed by the Kaiser emphasised the continuity of the design:

> I decree that for the small cruisers of the 1907 estimates, Ersatz-*Greif* and Ersatz-*Jagd*, the characteristics of the small cruiser Ersatz-*Pfeil*[19] be retained with only the modifications outlined below: …' [not repeated here – DN]

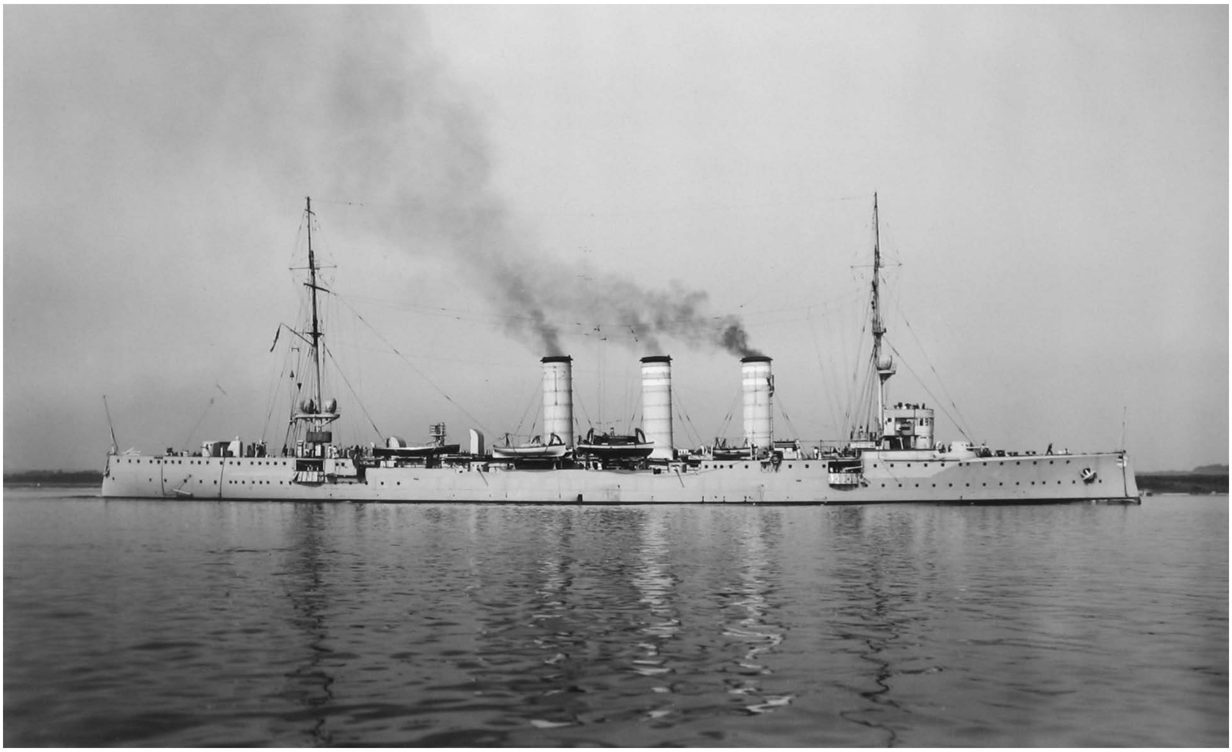
The Gun Controversy

The introduction and prolonged retention of the 10.5cm gun as the main armament of the small cruisers up to 1912 was destined to become one of the most hotly debated issues in the history of the IGN. As we have seen, Tirpitz had always opted for a larger calibre for his preferred III. class cruisers. However he was compelled, when evolving the IV. class cruiser into the 'small cruiser', to retain the armament of the former for fiscal reasons as a concession to Parliament. During the initial years of this type neither he nor most others in the service saw this as a disadvantage because the effect of the comparatively modern 10.5cm gun, together with its high rate of fire, appeared to be more than sufficient to engage the existing small cruisers or TBDs likely to be encountered in home waters and possible smaller adversaries abroad.

It will be recalled that the main task of the light cruisers was reconnaissance for the main body or leading advanced torpedo boat flotillas. They were thus not intended to engage in battle with hostile TBD flotillas or cruisers; rather they were intended to transmit vital information regarding the enemy's position and strength to the senior officer of the fleet, hence the focus on speed. Because of their generally small numbers, their role in fighting off attacking flotillas in a fleet action was restricted by their relatively small numbers. For this purpose, German battleships always retained a strong



Longitudinal section of *Kolberg*. The lengths of the engine rooms required by the Parsons turbines are strikingly evident and would become the source of lengthy discussions. (Author's collection)



Kolberg leaving the Kiel inlet on a calm day. The four white funnel bands identify her being the fourth vessel of the I. Scouting Group. (Author's collection)

secondary or tertiary battery. Cruisers therefore had to be able to defend themselves against the specified types of vessel only – there was no further discussion of their being pitted against a single large cruiser, even in numbers. This would become increasingly problematic in view of several new developments from the middle of the first decade of the 20th century.

First, the extended range of the newly-introduced 'heater' torpedo called for greater battle ranges, which in turn would render the 10.5cm gun less effective. Second, the size of the opposing TBDs had grown to such an extent that even multiple hits of this calibre would not guarantee effectively stopping the boats. And third, the Royal Navy had adopted modern quick-firing 6in (15.2cm) guns fore and aft in the new *Bristol* class designed in 1907, in a mixed arrangement (with 4in [10.2cm] secondary guns) similar to the one that Tirpitz had proposed several years before; this rendered the German ships' deck protection significantly more vulnerable. However, the front-line commanders still preferred the smaller calibre mainly because of its higher rate of fire. This is reflected in a statement by Admiral Hermann Jacobsen, long-time head of the Inspectorate for Naval Artillery, after directing a test firing of the new cruiser *Mainz*, sister to *Kolberg*, with the aim of:

> … determining whether the 10.5cm L/45 gun – the calibre's upper limit of effectiveness is around 8000m – would guarantee a sufficient number of hits and sufficient effects on the superstructures. … During three passes of the target vessel at between 6500m and 7900m, 190 rounds were fired and 36 hits obtained. … With regard to the ability to observe the fall of shot, the comparatively simple process of finding the range and the sheer number of hits, the Fleet's High Command thus expected a sufficient effect against unprotected cruisers equipped with open batteries on the weather decks to gain superiority of fire for a short duration. … *This proved to be a dangerous fallacy.*' [DN's italics][20]

We will return to this point again in Part Two, which will deal with the eventual change of direction concerning future cruiser designs and the long struggle to get the existing vessels partially up-gunned after the unfortunate experiences at the beginning of the Great War.

Acknowledgements:

My thanks to Dr Axel Griessmer, who started the preparation of some of the material before passing it to me for further work, and to Professor Aidan Dodson for proof-reading the initial draft and converting it into a more readable form.

Sources:

In general the article draws mainly from files archived in the Bundesarchiv-Militärarchiv (BA-MA) at Freiburg im Breisgau, of which the most relevant used for direct citation are named below:

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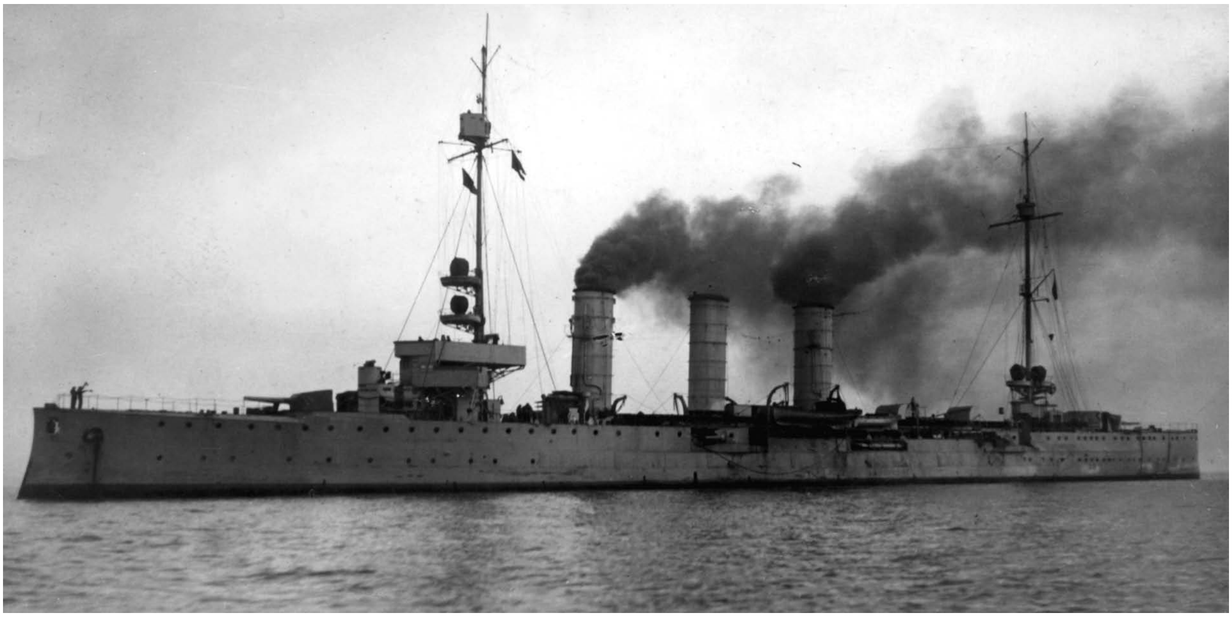
BA-MA RM3/348 – *Bau von Panzerfahrzeugen.*
BA-MA RM3/871 – *Bau Kleiner Kreuzer KOLBERG.*



Augsburg seen following her rearmament with six 15cm in place of the original twelve 10.5cm guns. The conversion was carried out in the winter of 1916/17 during the customary break in Baltic operations. (Author's collection)

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Endnotes:

[1] One reason that the Budget for Imperial spending was under pressure during this period was that the contract for constructing the Kaiser Wilhelm (Kiel) Canal had just been placed.

[2] A consequence of the policy that fleet cruisers should have a speed of 3 knots in excess of the contemporary ironclads (in this case the *Brandenburg* class).

[3] Cited in Besteck, *First Line of Defence*, 193ff.

[4] Published in *Marine-Verordnungsblatt* (MVBl) Nr 20/93, 233ff.

[5] This was partly because the Imperial Yacht *Hohenzollern*, much larger than any other contemporary avisos, also bore this official designation in a notorious attempt to hide her true purpose from parliamentarians.

[6] Bundesarchiv-Militärarchiv (BA-MA) RM3/348, 66ff.

[7] Besteck, *First Line of Defence*, 195.

[8] BA-MA RM3/3697, fol 4ff.

[9] BA-MA RM3/3697, fol 33ff.

[10] BA-MA RM3/2, fol 6.

[11] The letters were an innovation which accompanied the forthcoming Navy Law. They were misleading insofar as – due to problems with the preferred shipyards – 'B' (*Niobe*) preceded 'A' (*Nymphe*). There is even a drawing in the archives which shows an exact copy of *Gazelle*'s plans under the heading 'small cruiser B'.

[12] Four double-ended and one single-ended boilers.

[13] He was the official successor to Dietrich, despite not being qualified as a naval architect. After the death of Dietrich it had been decided that the head of the department should hold a military rank instead of being a civilian. Dietrich's true successor, Confidential Counsellor Johannes Rudloff, was formally subordinated to Eickstedt.

[14] RMA (ed), *Bauvorschrift für die komplette Maschinenanlage*.

[15] The number was made dependent on the success of *Lübeck*'s trials, so it appears that these were not initially fully satisfactory and only one cruiser with turbines was actually ordered.

[i6] The term 'machine canon' (MK) was used in the IGN to distinguish it from the 8mm machine gun. The difference lay in the ammunition; solid projectiles as well as explosive shells were fired from the machine canon, whereas the machine gun fired only solid projectiles.

[17] The IGN used the term 'quick-loader' in preference to the more common 'quick-firer'.

[18] BA-MA RM3/871 fol 29ff.

[19] *Emden*.

[20] Jacobsen, 249ff.

DESIGN TRENDS IN MODERN SURFACE COMBATANTS

Conrad Waters looks at the consequences of the many and varied factors influencing surface warship design since the end of the Cold War.

The end of the Cold War brought significant changes to the size, structure and operational priorities of the world's major navies. The conclusion of the confrontation between the 'western' nations on the one hand and the Soviet Union and its allies on the other resulted in a marked reduction in the number of vessels operated by many fleets, as the so-called 'peace dividend' channelled funding away from military programmes. These same fleets had to find a new *raison d'être* given that previous priorities such as 'blue water' oceanic submarine-hunting and littoral defence had – at least for a time – lost much of their relevance. For many the consequence has been a shift in emphasis towards global expeditionary operations to combat a rising tide of instability that followed the collapse of the old world order.

Contemporaneous with this changed environment has been the continued – and often accelerating – pace of development in many of the technological areas underpinning modern warship capability. Perhaps the most significant of these has been the rapid progress seen in computing and electronics. This has already had major implications for naval sensors, weapons and communications. It is increasingly making its influence felt with respect to unmanned and autonomous systems. In a reversal of previous experience, much technological innovation has been led by the consumer rather than the military sector.

The financial and technological backdrop has had wider design implications. For example, limited funding has resulted in a much greater emphasis on controlling

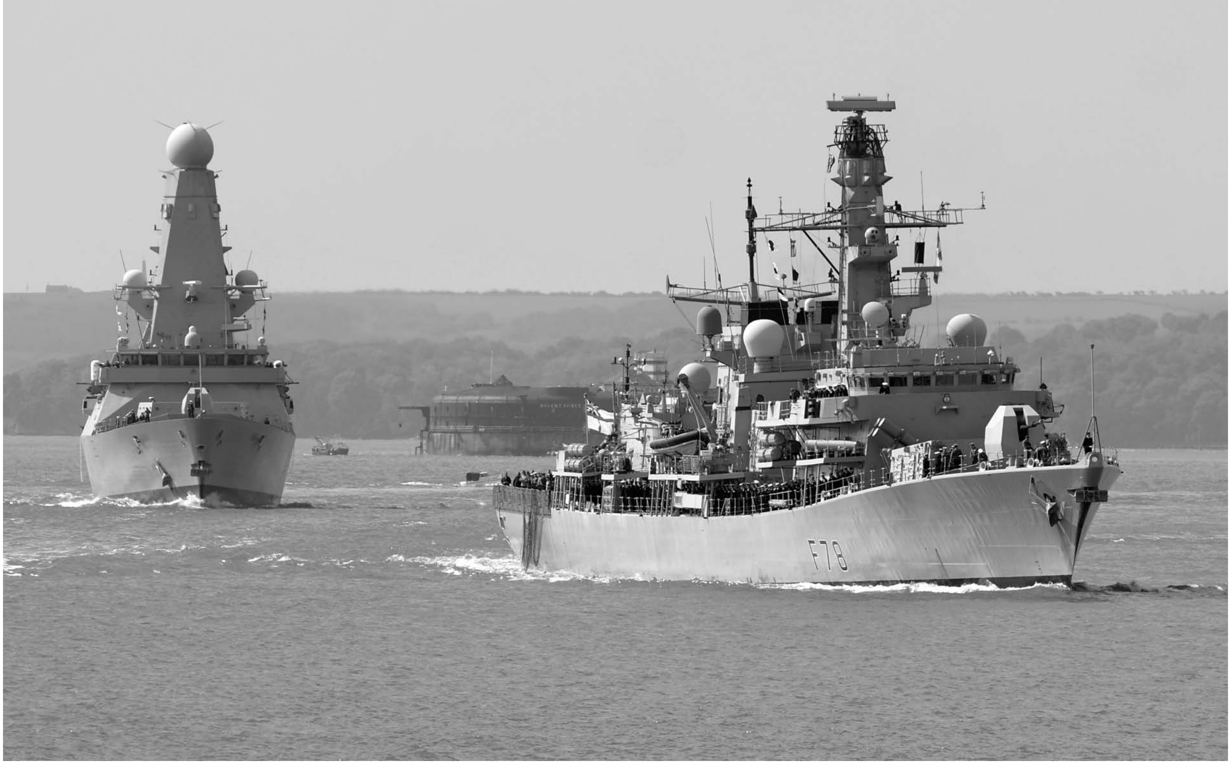

While some allowance has to be made for their different functions, this photograph of the British Royal Navy Type 23 anti-submarine frigate *Kent* leading the Type 45 air-defence destroyer *Dauntless* into Portsmouth Harbour in May 2015 is reflective of the generational design changes impacting surface combatants during the post-Cold War era. Notably, the more modern destroyer is visibly larger and pays far more attention to RCS stealth than her 1980s-designed predecessor. (Conrad Waters)

Table 1: **Evolution of Royal Navy Frigate Designs**

Class	**Type 12(I) *Leander***	**Type 23 *Norfolk***	**Type 26 *Glasgow***
Role:	General-purpose frigate optimised for anti-submarine warfare		
Year Commissioned	1963	1990	[Early 2020s]
Displacement	2,900 tonnes	4,300 tonnes	6,900 tonnes
Dimensions	113m x 13m x 5m	133m x 16m x 5m	150m x 21m x 6m
Length to Beam Ratio	9.1	8.3	7.2
Armament:			
guns	1 x twin 4.5in gun	1 x single 4.5in gun	1 x single 5in gun 2 x Phalanx CIWS
SAMs	1 x Seacat quad	32 x Seawolf VLS	48 x Sea Ceptor VLS
SSMs	–	2 x quad Harpoon	24-cell Mk 41 VLS for various weapons
A/S weapons	1 x triple Limbo A/S mortar	2 x twin A/S torpedo tubes	–
helicopters	1 x light helicopter	1 x medium helicopter	1/2 x medium helicopters or UAVs
Propulsion	steam turbines, 28 knots	CODLAG, 28+ knots	CODLOG, 26+ knots
Crew	260	185	157 [core]

Note:
Given considerable differences between published sources the above data should only be regarded as being indicative.

sustainment and other through-life expenses; this includes the cost of crewing.[1] Efforts to reduce manpower – and increasingly womanpower – through automation have not, however, proved to be a universal panacea. The more technically literate crew required to operate the new systems represents a fresh generation of sailors with higher expectations regarding pay, accommodation and other amenities.

The combination of these various factors has had a significant impact on modern warship design. Inevitably, change has impacted different navies in different ways. Variables such as national priorities, naval doctrine and design philosophy have all played a part, and there are always exceptions to general trends. Nevertheless, a number of common themes can be ascertained. This brief overview seeks to examine some of the main design trends in the post-Cold War period, focusing on modern major surface combatants. It also attempts to assess what the future might hold.

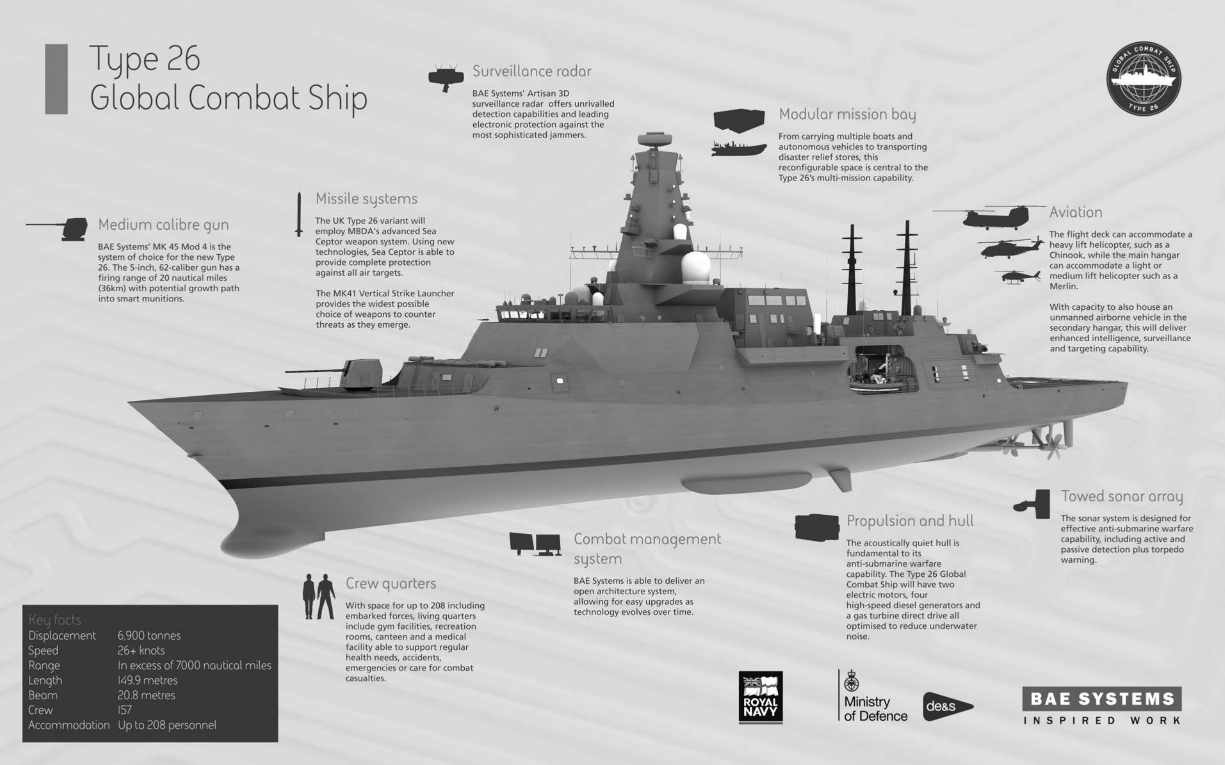
Size

The most immediately obvious trend in surface warship design over recent decades is that ships in any given category have become significantly larger in size. There have always between distortions in categorisation, the US Navy's large DLGs of the 1960s being a prime example. However, the situation has now been reached where many of today's current frigate designs meet or exceed former cruiser proportions. This trend was already evident in the latter stages of the Cold War but has accelerated subsequently. Table 1 provides a specific example of this growth with respect to British Royal Navy frigate construction; however, it is applicable to a greater or lesser extent to most major fleets.[2]

While no one single factor has driven this growth, key influences include:

Expanded User Expectations: A major consequence of the reduction in fleet numbers following the end of the Cold War is that navies have demanded higher levels of performance from their remaining ships. The basic, 'low end' combatants operated by many fleets in the Cold War era have largely disappeared, sometimes being replaced by vessels built to commercial standards and intended for purely constabulary tasks. Moreover, even though many of the remaining surface combatants are optimised for a particular role, most have either the capacity or potential to provide good multi-role performance across a wide spectrum of missions.[3] This requirement for enhanced and broadened mission capabilities has inevitably pushed size upwards. The switch in emphasis towards global expeditionary deployments experienced by many previous regional navies has also been noteworthy. This has tended to emphasise the benefits of size and internal volume in ships deploying far from home waters. In some ways, today's general-purpose surface combatants are often conducting traditional cruiser roles.

Greater Focus on Adaptability and Maintenance: Modularised warship equipment concepts introduced with the German Blohm & Voss MEKO design in the early 1980s and further developed by the Danish StanFlex technology have had a marked impact across the warship construction industry. These concepts have streamlined outfitting and improved overall adaptability. However, the relevant modules generally require more space than more traditional outfitting processes. Similarly, new support methods that emphasis maintenance of equipment by replacement in lieu of onboard



BAE Systems' Artisan 3D surveillance radar offers unrivalled detection capabilities and leading electronic protection against the most sophisticated jammers.

From carrying multiple boats and autonomous vehicles to transporting disaster relief stores, this reconfigurable space is central to the Type 26's multi-mission capability.

The UK Type 26 variant will employ MBDA's advanced Sea Ceptor weapon system. Using new technologies, Sea Ceptor is able to provide complete protection against all air targets.

The MK41 Vertical Strike Launcher provides the widest possible choice of weapons to counter threats as they emerge.

BAE Systems' MK 45 Mod 4 is the system of choice for the new Type 26. The 5-inch, 62-caliber gun has a firing range of 20 nautical miles (36km) with potential growth path into smart munitions.

The flight deck can accommodate a heavy lift helicopter, such as a Chinook, while the main hangar can accommodate a light or medium lift helicopter such as a Merlin.

With capacity to also house an unmanned airborne vehicle in the secondary hangar, this will deliver enhanced intelligence, surveillance and targeting capability.

The sonar system is designed for effective anti-submarine warfare capability, including active and passive detection plus torpedo warning.

The acoustically quiet hull is fundamental to its anti-submarine warfare capability. The Type 26 Global Combat Ship will have two electric motors, four high-speed diesel generators and a gas turbine direct drive all optimised to reduce underwater noise.

BAE Systems is able to deliver an open architecture system, allowing for easy upgrades as technology evolves over time.

With space for up to 208 including embarked forces, living quarters include gym facilities, recreation rooms, canteen and a medical facility able to support regular health needs, accidents, emergencies or care for combat casualties.

Key facts

Displacement	6,900 tonnes
Speed	26+ knots
Range	In excess of 7000 nautical miles
Length	149.9 metres
Beam	20.8 metres
Crew	157
Accommodation	Up to 208 personnel

This capability infographic of the new British Type 26 Global Combat Ship illustrates many of the influences – including modularity, combat management system architecture upgrades and new stealthy and more efficient propulsion technology – that are impacting current warship design. Surface combatants are also getting larger: displacing nearly 7,000 tonnes, the Type 26 is the size of a Second World War light cruiser. (BAE Systems)

support arrangements require more volume to provide the associated access and egress routes. For example, ensuring ease of maintenance to reduce ongoing costs was a key factor in the internal design of the Franco-Italian FREMM frigates. The German F125 *Baden-Württemberg* class takes this process a step further. Here key systems are duplicated to improve resilience on lengthy stabilisation deployments.

Equipment Volume Requirements: In addition to the widespread use of modular equipment concepts, other developments in the areas of weapons and sensors are also putting increased demands on internal volume. One example is the almost universal adoption of vertical launch system (VLS) technology. This has significance consequences in terms of both beam and depth margins in the area of installation. The relatively heavy multi-function radars placed high in a ship that are typically used in the air defence role have been another influence, placing heavy demands on stability. Both of these factors were, for example, key drivers in the size and dimensions of the British Type 45 *Daring* class destroyers. Length to beam ratios have been decreasing more generally, particularly in western designs.

Enhanced Crew Facilities and Standards: Although there has been a marked reduction in crewing levels in many fleets – and particularly among those of the more developed nations – improvements in overall standards have resulted in more rather than less space being allocated to sailors' accommodation. Further discussion on the factors driving these enhancements and their practical implementation is provided later in this article.

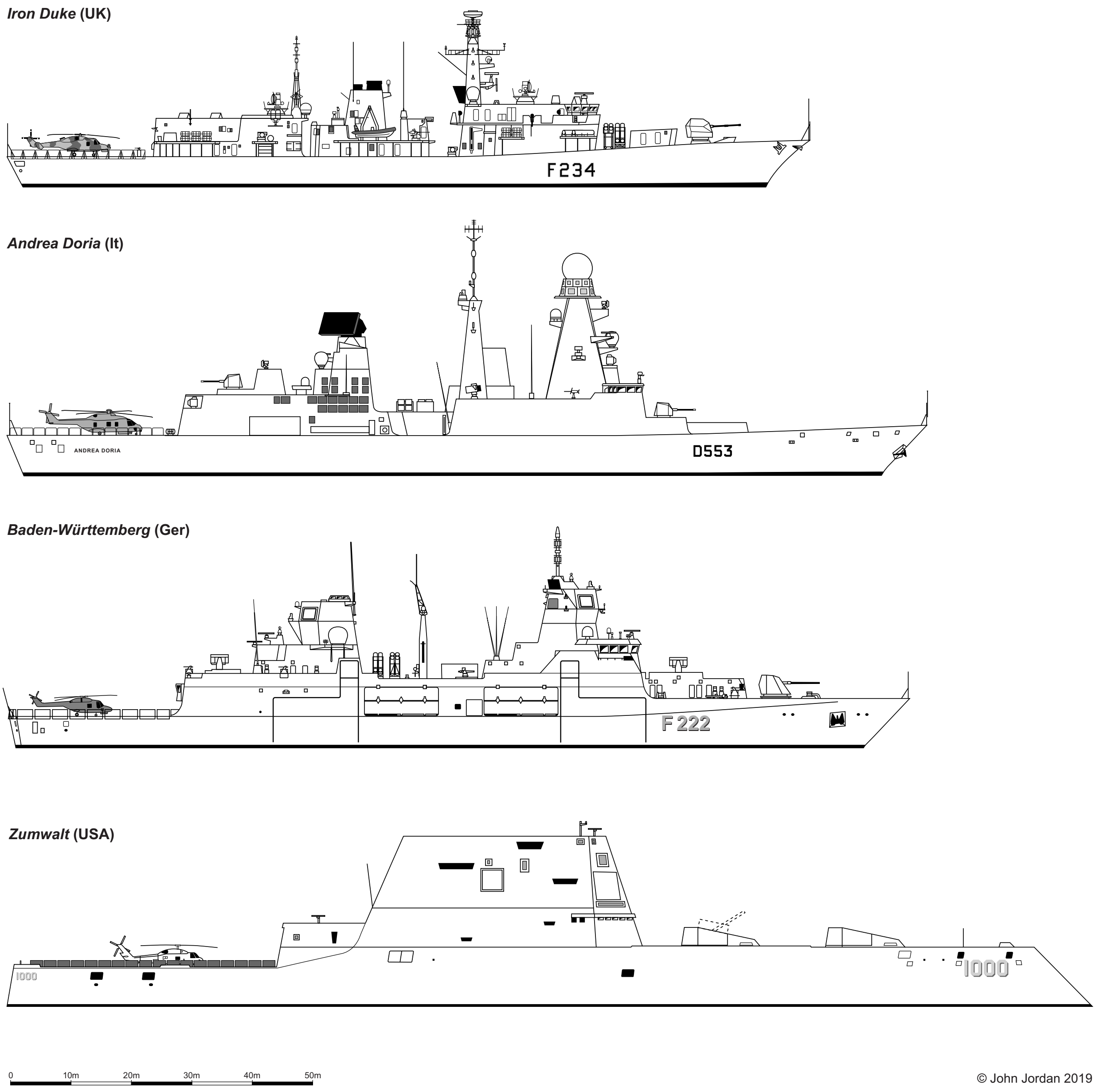
Growth in combatant size has inevitably impacted acquisition costs. However, it seems navies have, by and large, concluded that the advantages offered by size outweigh the drawbacks. The old adage 'air is free, steel is cheap' may well have had an influence on this conclusion. This reflects the fact that warship procurement costs are driven far less by the construction of the basic 'platform' than the equipment it contains. The adage may, however, be something of a trap. In addition to the fact that larger ships are likely to have higher operating expenses with respect to items such as fuel, the temptation to fill all available space with expensive technology can often prove irresistible.

Stealth

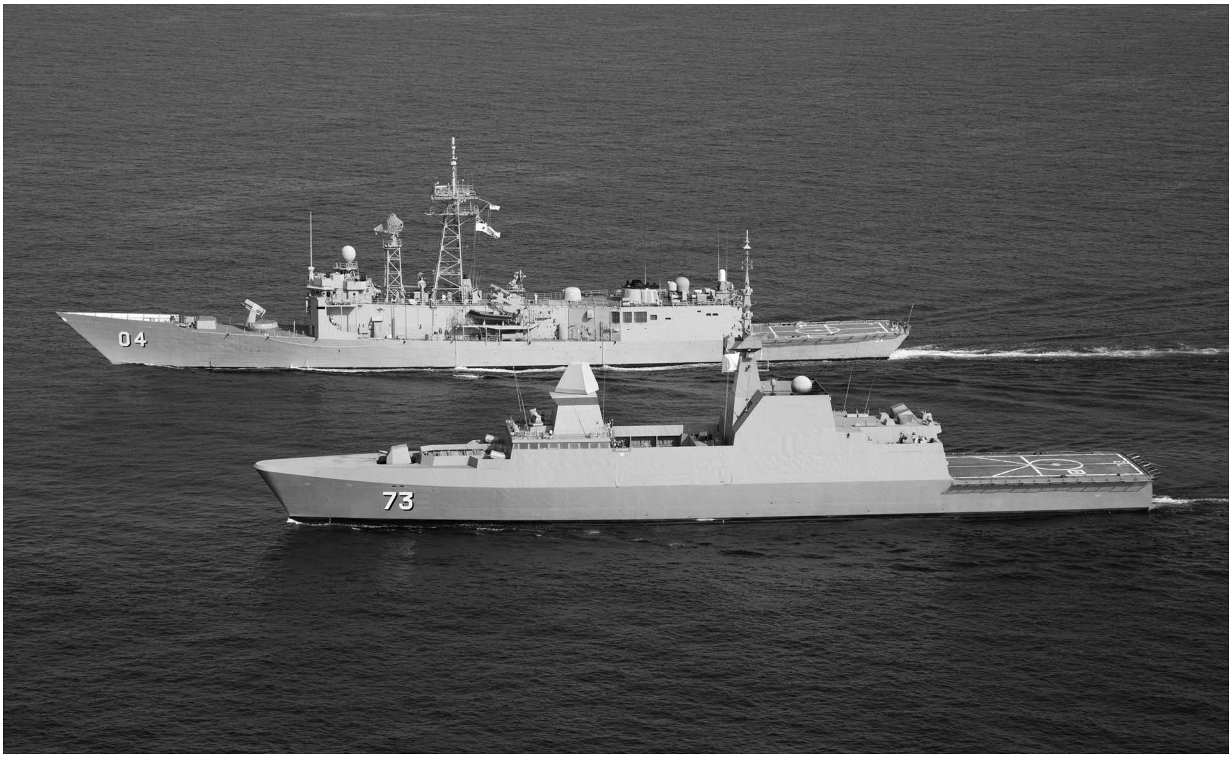
Another very apparent aspect of recent warship design has been the increasing focus on stealth. The French *La Fayette* class commissioned from 1996 onwards is commonly regarded as the forerunner of this trend. They were the first major surface combatants whose external appearance was driven largely by a desire to minimise their radar cross section (RCS). Stealth measures adopted in the design included the inclination of hull and superstructure sides to reduce radar reflectivity, the concealment of equipment such as boats, bollards and capstans, and the use of radar-absorbent materials on masts and other key areas. The overall combination resulted in a very different appearance from that of previous frigates.

This focus on reducing radar signature was not without drawbacks. The use of an angular structure is inefficient from the perspective of internal design. It can

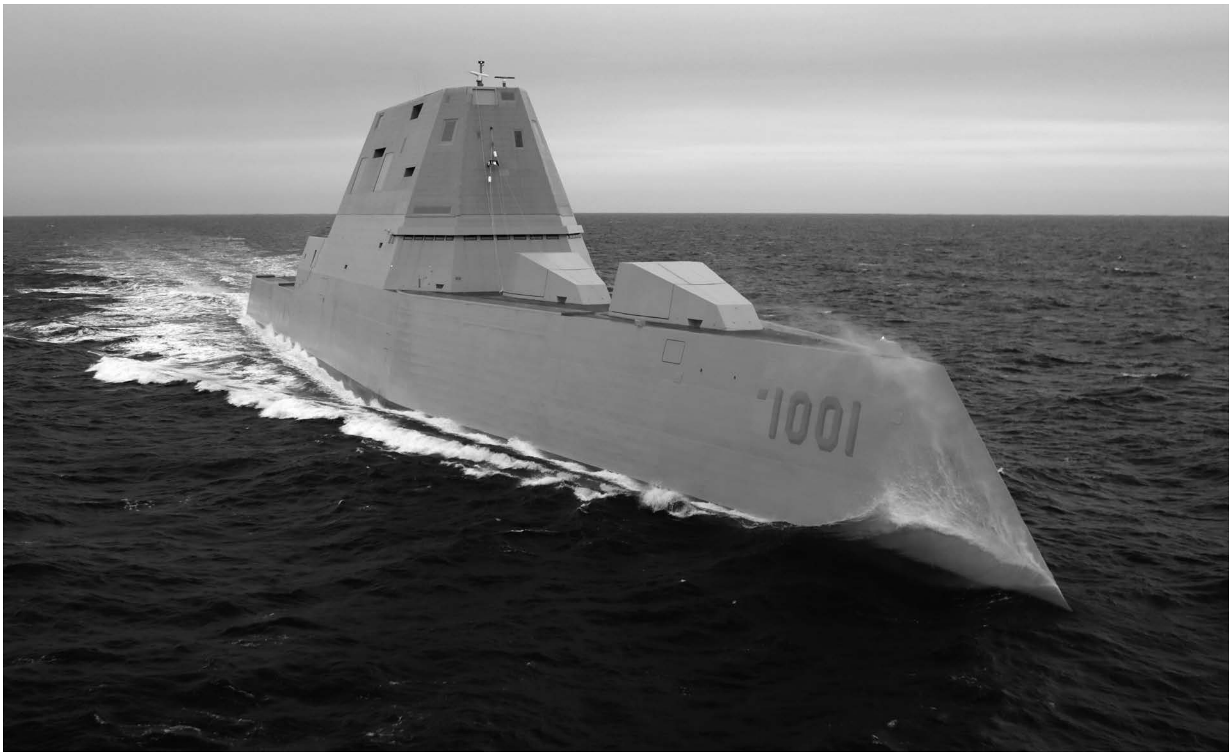
Contemporary Major Surface Combatants with 'Stealth' Characteristics



The British Type 23 frigates (*Iron Duke* depicted) commissioned from 1990 onwards benefited from a high level of acoustic stealth and adopted some measures – including the angling of hull and superstructure sides – to improve RCS. However, a much greater focus on reducing RCS is apparent in the Franco-Italian 'Horizon' design (represented here by *Andrea Doria*) of the early years of the new millennium, which was heavily influenced by the stealth frigate *La Fayette.* This focus on visual stealth has subsequently seen near-universal adoption, as illustrated by the latest German F125 class frigates of the *Baden-Württemberg* class. These show further evolution of stealth technology, including adoption of the increasingly popular 'X'-form cross section. Meanwhile, having initially been slow to follow the French lead, the US Navy has taken the focus on stealth to a new level with the missile destroyers of the *Zumwalt* class.



The Republic of Singapore Navy's *Supreme* – one of six *Formidable* class stealth frigates derived from the French *La Fayette* design – pictured alongside the Royal Australian Navy's FFG-7 class frigate *Darwin* in 2017. The radical approach to minimising RCS heralded by *La Fayette* – including the inclination of hull and superstructure sides and the concealment of much equipment – has had an enduring impact on surface combatants' visual appearance. (Royal Australian Navy)



The second US Navy *Zumwalt*-class destroyer *Michael Monsoor* (DDG-1001) pictured on acceptance trials early in 2018. Having initially taken a conservative approach to implementing RCS-minimising stealth technologies, the US Navy's use of a tumblehome hull and monolithic deckhouse in the *Zumwalt* class was largely driven by stealth considerations. (General Dynamics Bath Iron Works) result in awkwardly shaped compartments that have added to the upward pressures on overall warship size previously discussed. Moreover, the reduction in open decks driven by the need to avoid reflective angles complicates access and results in an increased requirement for internal passageways that can impact damage control arrangements. Deletion of guardrails and lifelines are an additional complication to safe operation at sea. There was much contemporary criticism of the French approach for prioritising stealth over mission functionality. Other major navies initially took a more conservative approach, notably the US Navy: while its slightly earlier *Arleigh Burke* (DDG-51) class did incorporate stealth measures, RCS reduction was far less of an overriding feature of this design.

Nevertheless, it is evident that *La Fayette* heralded a trend that has exerted a dominant influence on current surface combatants. The design was a swift export success, ultimately gaining sales to Saudi Arabia, Singapore and Taiwan. Perhaps more significantly, it also acted as a key reference for the tripartite Anglo-Franco-Italian 'Horizon' project that ultimately spawned the *Andrea Doria, Forbin* and Type 45 classes. Current surface combatants originating from these countries, notably the Franco-Italian FREMM and British Type 26 global combat ship types, continue to reflect the *La Fayette* heritage. Many other countries have also adopted a similar approach. For example, Germany has produced a series of designs with a RCS-reducing 'X' form structure both for national service and for export. Perhaps confirming that 'imitation is the sincerest form of flattery', the US Navy's *Zumwalt* (DDG-1000) class has adopted an unusual tumblehome hull and monolithic composite deckhouse as part of a comprehensive series of stealth measures.

Efforts aimed at minimising RCS are the most evident result of the current focus on stealth. However, it is important to appreciate that stealth technology takes many forms, and current warship designs aim to take a comprehensive approach to reducing their signature. Acoustic stealth is another major, although visually less obvious, design imperative. It seems to be growing in importance as anti-submarine operations regain significance. The use of raft-mounted machinery and elastic mounts, introduced in surface warships from the early 1980s onwards, has become increasingly common. They are frequently used in conjunction with diesel-electric propulsion, particularly in warships optimised towards anti-submarine warfare. Thermal emissions are also being subjected to much more systematic and considered analysis, with infra-red signature suppression (IRSS) devices growing in sophistication. In addition to a range of traditional engine exhaust IRSS devices utilising air cooling, this has seen the use of (above) waterline diesel exhausts and seawater cooling in designs such as the German K-130 *Braunschweig* class corvettes and the

A typical Royal Danish Navy Stanflex equipment module. The use of such equipment – that can be plugged into pre-prepared positions – allows ships to be rapidly re-equipped for various missions but requires additional volume. (US Navy)

French *Aquitaine* class FREMM variants.[4] Meanwhile the need for electronic stealth has been reflected, *inter alia*, in a new generation of 'low-probability-of-intercept' radars often based on active phased array technology.[5]

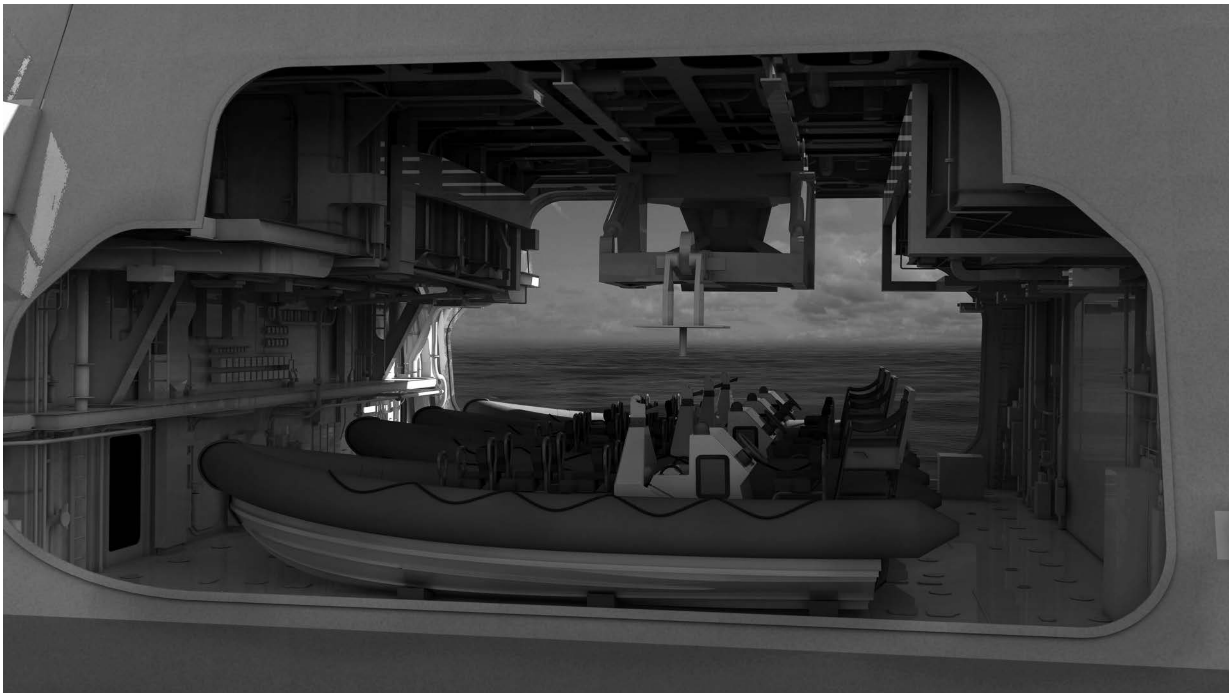
Systems Modularity

The potential advantages of the prefabricated, block construction of warships are long-established, and levels of pre-outfitting continue to expand. However, a more recent development is the use of modular weapons, sensors and associated systems. These are largely based around the creation of standardised interfaces with a ship's power and combat architecture. As previously noted, the German Blohm & Voss shipyard's *Mehrzweck Kombination Funktions Einheits* (MEKO) system heralded this approach. It involves the use of pre-prepared positions located in appropriate areas of the ship into which different modules – known as 'weapons functional' units and 'electronic functional units' – can be slotted. The modules are typically configured as containers or pallets. Both positions and modules contain predetermined physical interfaces with the combat system and other ship services, such as electrical power and ventilation.

The merits of the MEKO system were much debated when the technology was first introduced in the 1980s. The modular outfitting technique significantly eases construction, allowing fabrication of the ship platform to proceed in parallel with assembly and testing of the functional units. It also facilitates the replacement of obsolescent systems. Perceived drawbacks included the potentially restrictive nature of the predetermined interfaces and the size penalty inherent with the technology. The latter is driven by the need for the positions to accommodate the heaviest and most demanding systems options. The weight and volume demands of the standardised containers and pallets are an additional factor. In practice, the advantages of modularity have been seen to outweigh its demerits as time has progressed, and the MEKO approach has been widely emulated.

The Royal Danish Navy was quick to adopt modularity. It introduced its Standard Flex (or StanFlex) system just as the Cold War was drawing to a close. In similar fashion to the Blohm & Voss technology, this is based on different combinations of weapons and equipment mounted in standardised containers. These can be slotted into pre-prepared positions to allow one ship to be adapted for a range of different missions. One particular feature of StanFlex is the rapidity with which modules can be removed and replaced. This allows a ship to be adapted for a different role within the course of a few hours. This approach had, in turn, a significant impact on the US Navy's littoral combat ship concept. A big problem – discovered by both navies – was the difficulty in providing appropriate crew training to permit fully effective performance in the variety of roles envisaged. This problem arose notwithstanding the provision of mission specialists with the modules.[6]

One particular feature seen in the littoral combat ship designs that is now gaining widespread acceptance is the provision of a bespoke mission bay to accommodate a range of specialised mission modules. This concept has



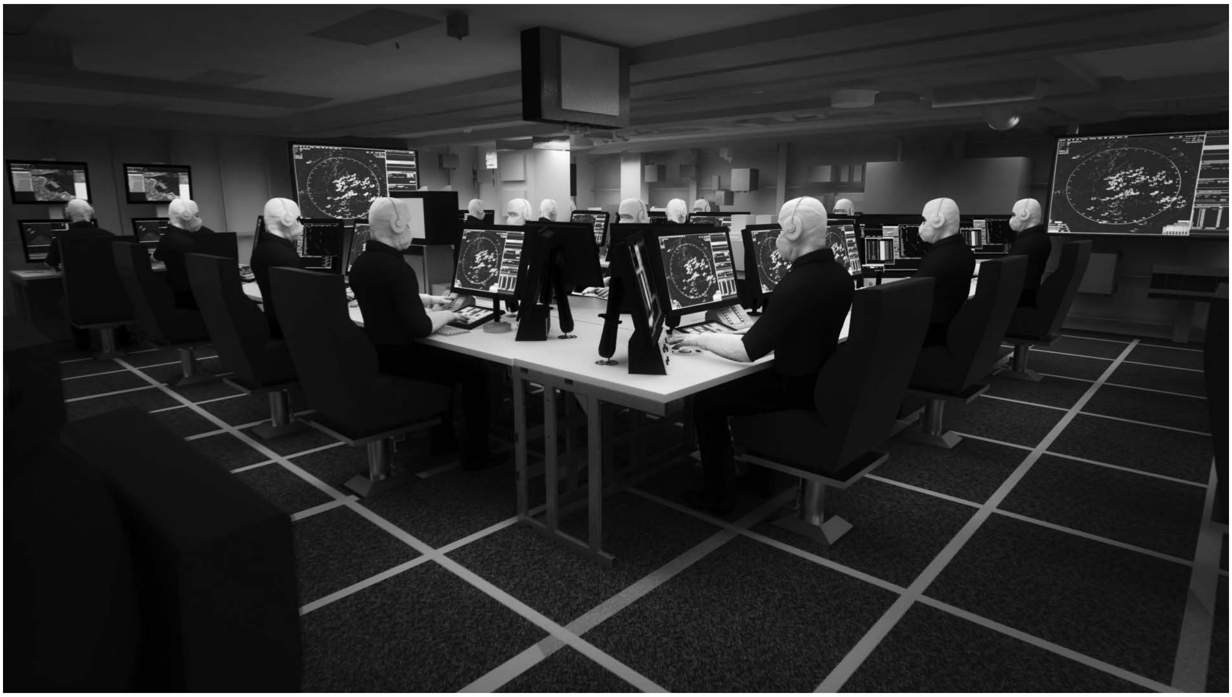
The concept of a reconfigurable mission bay capable of housing a range of containerised equipment and other systems is becoming increasingly popular. This graphic of the adaptable mission bay incorporated in the Type 26 Global Combat Ship design shows it configured for Special Forces' RHIB-type fast assault craft. (BAE Systems) also been described as a 'mission' or 'flex' deck. As well as providing space for equipment housed in standard containers, these spaces are increasingly being seen as essential for housing and operating the new generation of unmanned and autonomous vehicles that are finding their way into front-line operations. A recent example is the adaptable mission bay linked to the adjacent hangar in the British Royal Navy's Type 26 Global Combat Ship. It can accommodate a wide variety of equipment dependent on particular mission requirements. The space is large enough to house up to ten TEU containers. Alternative payloads could include various types of unmanned vehicle. The bay's location next to the helicopter hangar is particularly useful in supplementing aviation capabilities, up to and including the ability to ship a second, Merlin-sized helicopter.

Another modular approach that is gaining traction is the integrated mast concept. This is, perhaps, most readily identified with Thales' i-Mast. The i-Mast consists of a discrete housing that incorporates all of a ship's major radars, other sensors and communications equipment in a single structure. A major advantage over more traditional sensor layouts is the avoidance of interference between different systems. In common with other modular technologies, it also offers more efficient and economic installation and subsequent ease of maintenance. Initial installations have been in second-line offshore patrol vessels and support ships. However, the approach is equally applicable to front-line combatants. This is demonstrated by French Naval Group's PSIM panoramic sensors and intelligence module, which is being installed in 'Gowind' series corvettes and light frigates.[7] An interesting feature of the PSIM approach is the integration of the combat information centre within the base of the mast structure.

Combat & Weapons Systems

The broader area of combat management systems is another that has seen significant change in recent years. The later years of the Cold War were marked by efforts to achieve the full integration of the tactical picture provided by a ship's combat management system (CMS) with the required fire control response. This was initially

The Aegis system introduced with the US Navy cruiser *Ticonderoga* (CG-47) – pictured here in late 1982 shortly before delivery – achieved a level of fire control system integration that has subsequently been widely emulated. However, the centralised computer architecture retained for this class – albeit in a reduced form – has now been superseded by an approach that distributes computing power around the combat system. (US Navy)



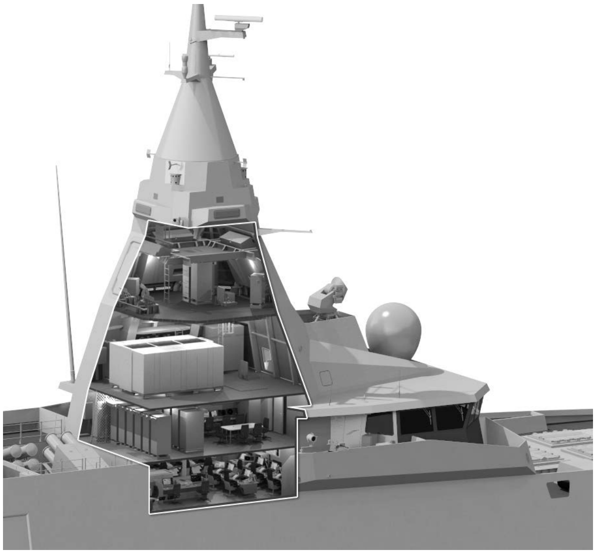
A computer-generated image of the operations room layout proposed for the Type 26 Global Combat Ship. The ergonomics have more in common with a modern open-plan office than the legacy facilities found in Cold War-era designs. (BAE Systems)

realised in the US Navy's automated Aegis weapon system, which was introduced operationally on board the cruiser *Ticonderoga* (CG-47) in 1983. The automation and, thus, speed of response inherent in Aegis was designed to counter the threat of saturation Soviet air and missile attack. However, it has proved equally relevant to the threat from 'pop-up' missiles during post-Cold War littoral operations. It took considerable time for other navies to achieve the level of performance provided by Aegis and its associated multi-function radars. However, a range of comparable systems is now in service the world over.

The expansion of CMS capabilities has been assisted by the rapid pace of development in computing power over recent decades. This has been associated with a transition from bespoke computers built to military specifications towards an almost total reliance on commercially-derived hardware and associated operating systems. Alongside this change has been a shift away from centralised computing networks in which consoles, sensors and weapons are all connected to one or more central computers in a star architecture. Instead, distributed computing concepts such as the DNA system introduced with the Royal Navy's Type 23 frigates in the 1990s disperse computing power around a local area network. Aegis started life using a centralised computing approach based on US Navy-developed AN/UYK-7 machines; however, it has subsequently transitioned to a distributed architecture.

Distributed combat management systems avoid the single point of vulnerability inherent in centralised computing. They also typically employ an open architecture that is easier and cheaper to upgrade at periodic intervals. The technology continues to evolve. For example, the British Royal Navy's latest Shared Infrastructure – developed by BAE Systems – allows software from multiple systems providers to be hosted on a common hardware platform. This allows all computerised ship functions to be accessed through a single console and makes it easier to incorporate bespoke software solutions into the system. It may assist the early introduction of specialised technologies such as artificial intelligence. The vulnerability of open-architecture networks to cyberattack remains a concern. The experience of other security-critical computing functions, particularly in the financial services sector, has been drawn on to ensure the technology's suitability.

Perhaps one of the most immediately visible changes in warship combat management systems over recent decades has been in the layout of operations rooms (combat information centres). Traditional densely-packed configurations have given way to more spacious layouts that have much in common with the feel of an open-plan office. The additional demands on internal volume have tended to see those navies with a previous preference for burying command spaces deep in the hull move these facilities to more vulnerable locations higher in the superstructure. The ergonomics of combat information centre design have also extended to the ubiquitous CMS consoles that allow a ship's crew to interact with the system. Many of these consoles have multi-screen displays. However, the latest variant of Thales' popular TACTICOS system uses a single large screen on the basis of feedback that this is more user-friendly.



A graphic of the integrated mast assembly due to be incorporated into the French Navy's new *frégate de défense et d'intervention* (FDI). A similar approach has previously been adopted with the PSIM mast installed in the Gowind series of frigates and patrol vessels produced for export. Note that the mast module includes the complete operations room complex located at its base. (Naval Group)

Looking beyond CMS advances to other developments in weapons and sensors, two main changes stand out. One is the widespread use of vertical launch systems in place of conventional trainable missile launchers. The other is the replacement of traditional mechanically-directed radars with electronically-scanned arrays. Both of these changes have been instrumental in the enhanced warship air defence capabilities associated with new combat management systems such as Aegis. Both have also had a significant impact on warship appearance, assisting with the enhancements to RCS stealth previously discussed. The ability of electronically-scanned radar to use fixed panels in lieu of mechanical rotation has had a particularly marked visual impact on those ships that have adopted such systems. The provision of 360° coverage with such fixed panels can present problems with respect to both topweight and optimal location. Accordingly, their use was first focused on larger surface combatants. However, suitable non-rotating arrays are now being installed in smaller frigates, including Norway's *Fridtjof Nansen* class and France's new *frégates de defénse et d'intervention* (FDI).

Although widespread use by surface combatants is still in its infancy, the impact of autonomous systems in terms of suitable operating and storage space has already been touched upon. Also starting to have significance is work on energy-directed weapons, such as lasers.

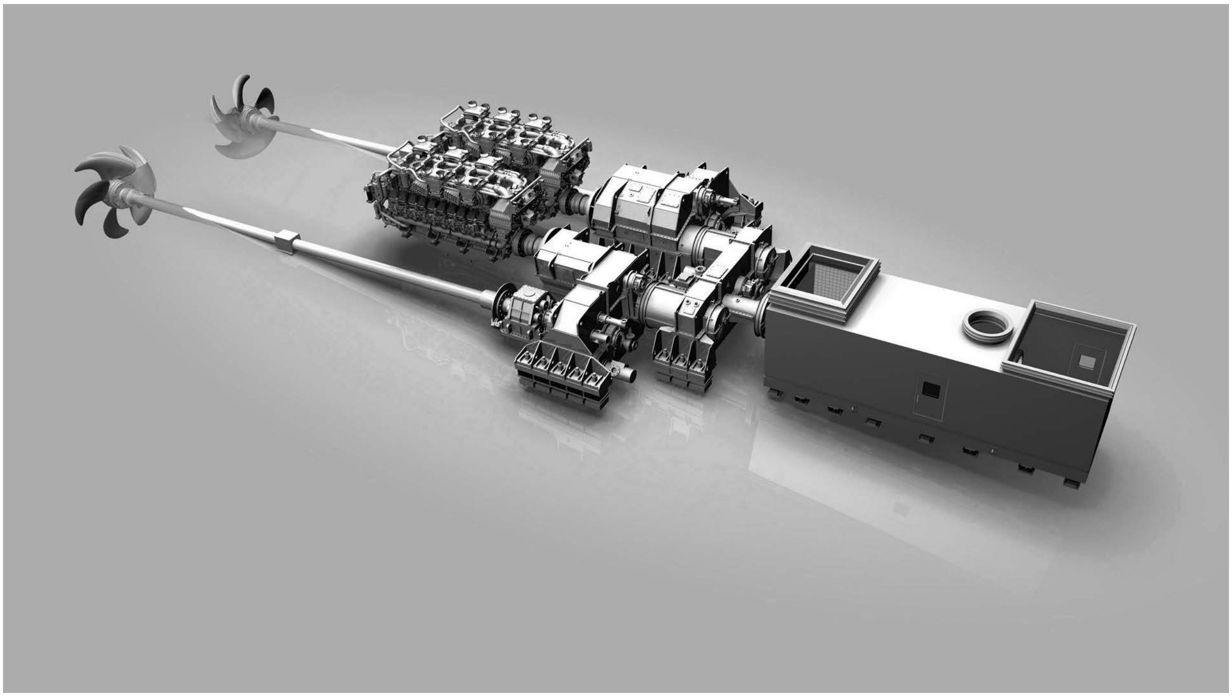
Propulsion Systems

The dominant propulsion system used by major surface combatants throughout the twentieth century was undoubtedly the steam turbine. However, this period of domination was starting to draw to an end during the later years of the Cold War. In spite of the levels of efficiency and power achievable from high pressure steam plants, they suffered from several disadvantages. In addition to requiring considerable space for the separate turbines, boilers and fuel bunkerage, their inherent complexity made heavy demands on both crewing and maintenance. Operationally, they also required considerable time to raise steam prior to sailing. With the niche exception of nuclear-powered steam turbines, steam machinery has largely disappeared from today's warships.

The replacements for steam propulsion have been diesels and gas turbines. The former have a long history in warship design and offer advantages in terms of fuel efficiency and ease of maintenance. However, it has long proved difficult to achieve the very high levels of power required by a fast, front-line combatant in a size-restricted hull. The level of vibration and noise inherent in a diesel can also be a significant detractor. This is particularly so when used for stealthy, anti-submarine missions. However, steady improvements in diesel design and associated silencing have reduced these drawbacks, and direct diesel propulsion continues to be widely used even in major surface combatants operated by the larger navies. This is particularly the case where high maximum speeds and ultra-silent operation are not priorities. Current examples include China's extensive series of Type 054A frigates, France's planned FDIs and the projected British Type 31e frigates that will be derived from the Danish *Iver Huitfeldt* class design.

It is, however, the gas turbine that has come to dominate the market for the largest and most sophisticated front-line warships. First entering service in major surface combatants during the 1960s, gas turbines offer the high power associated with steam turbine propulsion in a much more compact and lightweight unit. They also have the advantage of much quicker start-up. The major surface warships of the world's dominant navies – such as the US Navy *Arleigh Burke* (DDG-51) and Chinese Type 055 *Nanchang* class destroyers – use combined gas and gas (COGAG) propulsion. However, gas turbine propulsion does have a major disadvantage in that the turbines are efficient only over a very narrow power range. This, in effect, means that gas turbines tend to offer poor fuel economy at the low speeds that tend to dominate a warship's peacetime operating profile. A widely adopted solution has been to specify a combined propulsion arrangement with prime movers of different power for cruising and maximum speed. This could involve the use of gas turbines of different power outputs. However, combined diesel or gas (CODOG) or combined diesel and gas (CODAG) plants have tended to be more popular. In these systems, the diesels are used for low speed operation, with the gas turbines being used as an alternative or to boost the source of power when higher speeds are required.

A more recent trend has been the emerging use of

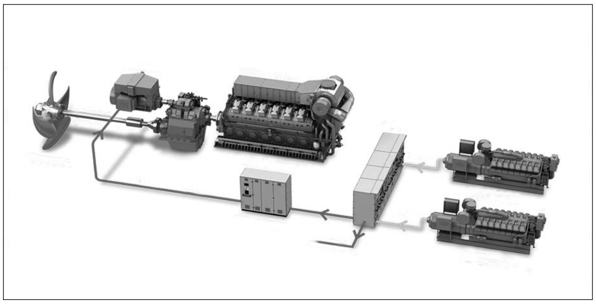


CODOG and CODAG propulsion systems – the latter is illustrated here – mechanically connect both diesel and gas prime users to a ship's propeller shafts to allow the cruising efficiency of diesels to be combined with the potential for higher speeds inherent in gas turbines. Whilst this technology is still in common use in surface combatants, new hybrid electro-mechanical or full electric propulsion is growing in popularity. (Rolls-Royce)

either hybrid electro-mechanical or full electric propulsion. These approaches involve the use of a ship's main diesel engines or gas turbines to generate electricity to power electric motors connected to the shaftlines as opposed to providing power directly to the shafts via gearing. With hybrid systems, for example in a typical combined diesel electric or gas (CODLOG) configuration, electric operation is used for lower speeds and direct drive kicks in when higher-speed sprinting is required. With full integrated electrical propulsion (IEP), all propulsive power is provided via the motors. Consequently, there is no direct connection between the prime movers and the propeller shafts.

This trend reflects several considerations. Technological developments have tended to place higher and higher loads on the electrical capacity needed for shipboard systems, sensors and weapons. This means more and/or larger generators are required. Benefits can therefore be gained from combining the energy requirements of propulsion with those for shipboard 'hotel' services. The result is a net reduction in the total number of engines and associated auxiliaries and ducting installed. There is also the potential to achieve reduced fuel consumption through balancing propulsion and hotel load.[8] The possibility of physically disconnecting generators from the rest of the propulsion chain can have additional design benefits. For example, they can be located in the optimal position for maintenance or for acoustic stealth. The decoupling of the electric motor from the main reduction gearbox in itself provides an exceptionally quiet machinery state that helps maximise a ship's performance in underwater warfare.

The British Royal Navy has been in the forefront of the operational deployment of electric propulsion. Its 1990s-era Type 23 frigates were trend-setters in the use of hybrid electro-mechanical propulsion, adopting a combined diesel-electric and gas (CODLAG) system. Four raft-mounted Paxman Valenta diesel generators supplied the electrical network and drove two GEC direct current electrical motors for silent cruising. Two Rolls-Royce Spey gas turbines provided supplementary power for high-speed sprinting. The use of electrical motors in



An illustration of a propulsion system combining direct diesel drive with diesel-electric drive by means of an electric motor connected to a diesel generator-powered electrical network. The electricity generated can also be used for shipboard 'hotel' services. CODLOG or CODLAG systems tend to be a more popular option on current frontline combatants due to the gas turbine's ability to provide higher maximum speeds. (Rolls-Royce) combination with acoustically-silenced generators meant that the class was regarded as having the lowest noise profile of any surface combatant at the time. CODLAG or CODLOG technology has subsequently been specified for numerous warships. These include the existing Franco-Italian FREMM, German F-125 and Republic of Korea Navy FFX-II frigates. Uniquely, Japan has adopted combined gas-electric and gas (COGLAG) propulsion for some of its recent surface combatants. The future British Type 26 and Spanish F-110 frigates will both also use electro-mechanical propulsion systems.

The Royal Navy's innovative use of full integrated electric propulsion (IEP) in its Type 45 *Daring* class destroyers has been less successful. The class's current generation plant comprises two 25MW Rolls-Royce WR-21 intercooled recuperated (ICR) gas turbines and two 2MW Wärtsilä 12V200 diesel generators. These feed two high voltage switchboards that distribute power both to the ship's systems and, through two propulsion converters, to two 20MW GE advanced induction motors that drive the twin shafts. A major weakness has been the lack of balance between the diesel and gas turbine generating capacity. When coupled with reliability problems impacting the WR-21 generators, this has led to a number of well-publicised electrical system failures.[9] There have also been unrelated teething troubles with the IEP system in the US Navy's *Zumwalt* class destroyers, to date the only other front-line surface combatants to adopt the system. This somewhat chequered track record may have discouraged use in similar vessels. However, IEP has been successfully implemented in other warships, including the *Queen Elizabeth* class aircraft carriers. It has significant potential in terms of efficiency, flexibility and shipboard electrical capacity. The last-mentioned factor will be of particular relevance as energy-directed weapons become a reality. It suggests IEP will become increasingly popular as the technology matures.

Survivability & Structure

An accurate understanding of current warship survivability is difficult to acquire given limited information in the public domain. For much of the Cold War, the incorporation of passive protection such as armour in warships appears to have had a lower priority than, for example, defensive weapons and countermeasures. This possibly reflected the fact that any 'hot war' was likely to be short, limiting the value of any ships that suffered significant action damage. More attention was paid to defeating the consequences of attacks that might not

One of four German F123 class frigates commissioned between 1994 and 1996, *Mecklenburg-Vorpommern* reflects the increased focus on survivability that followed the Falkland Islands War. This included the use of box girders to increase hull strength, the incorporation of double-skinned bulkheads and increased fire-zone self-sufficiency. (Bundeswehr) result in total incapacitation. This, perhaps explains the greater focus on shock resistance.

Passive protection now appears to be more in fashion. An important watershed was the Falkland Islands War. This vividly illustrated the consequences of attacks on modern warships in terms both of materiel and personnel. Its impact is reflected in the improved levels of damage resistance built into the Type 23 frigates designed in the aftermath of the conflict. This included strengthened, blast-resistant bulkheads and the creation of fully self-sufficient damage control zones. A similar emphasis is evident in other contemporary warships, such as the provision of box girders, double-skin bulkheads and increased fire zone self-sufficiency in the German F123 *Brandenburg* class. This focus has continued in subsequent surface combatants. The post-Cold War environment of more limited conflict in which the threat of damage from terrorist attack is a real danger has been an important influence.

An important aid to survivability has been the development of increasingly sophisticated platform management systems. In addition to controlling propulsion and associated ship systems, these can automatically monitor and respond to instances of damage. This helps to counterbalance the impact of lean manning on any emergency response.

Seemingly at odds with the increased focus on survivability has been a convergence of naval and commercial design practices. This has two main aspects. First, constraints on resources in the post-Cold War era saw navies look to save money by adopting commercial techniques for second-line warships and support vessels where the risk/reward balance was seen as acceptable. This has sometimes been extended to non-critical areas of front-line warship design. More broadly, significant cuts to 'in house' technical staff resulted in many navies outsourcing more and more elements of warship design to the shipyards. This has made it difficult for them to maintain and monitor their own design and construction standards. The consequence has been that responsibility for this process has increasingly been transferred to commercial classification societies, which have developed their own naval rules.[10] To some extent this has, of itself, encouraged a convergence of design practices, particularly since navies are under increasing pressure to comply with a host of national and international rules and regulations. The extent to which the standards promulgated under these new rules will withstand the test of combat has yet to be tested.

Accommodation & Crewing

One area where civilian standards have had a marked impact on warship design is that of crew facilities. The United Nations International Maritime Organisation (IMO) has established a number of conventions that have influenced warship habitability. These include the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention Preventing Pollution of the Marine Environment (MARPOL). These standards are not directly binding on navies; in practice, however, navies have become increasingly compliant. MARPOL requirements have had a particularly significant impact on the design of naval auxiliaries, but other aspects of the regulations have influenced front-line combatants. For example, the need to stow garbage on board ships and the requirement to install sewage treatment plants have added to the ongoing pressures in internal volume.

The changing balance between crew size and accommodation standards has already been touched upon. This balance has varied from navy to navy. However, a near-universal influence has been the increasing complexity of the technology installed in warships and a resultant shift towards a more technically-literate and professional crew. In effect, technological advances – particularly in automation – have dramatically reduced the number of sailors required to crew a warship but the remainder are more highly-skilled, senior and expensive. This is illustrated in Table 2, which highlights the differences between the 1970s and contemporary practice in France's *Marine Nationale*.

The new generation of professional sailors clearly has higher expectations than yesterday's largely conscript crews. Personnel shortages the world over mean that recruitment and retention are particular issues. This has been reflected in a switch from communal berthing and sanitary areas to smaller cabins, often with attached 'wet rooms'. This shift has also helped to resolve the additional complications that arise from the growing numbers of female crew. In similar fashion to weapons and sensors, cabins are now often installed as prefabricated, modular units.

One interesting aspect of the influence of societal change relates to expectations of a generation accustomed to constant connectivity to the internet and social networks. This has had important implications for the personal communications facilities provided on warships, as well as for associated information security.

Table 2: **Changes in Warship Crew Size and Structure**

Class	***Tourville* (F 67)**	***Aquitaine* (FREMM)**
Year Commissioned	1974	2012
Displacement	6,100 tonnes	6,050 tonnes
Dimensions	153m x 16m x 5m	142m x 20m x 5m
Complement	282	108
… of which Officers	17 (6%)	22 (20%)
… of which Petty Officers	122 (43%)	70 (65%)
… of which Ratings	143 (51%)	16 (15%)
[… of which Women	0	8-10%]

Note:

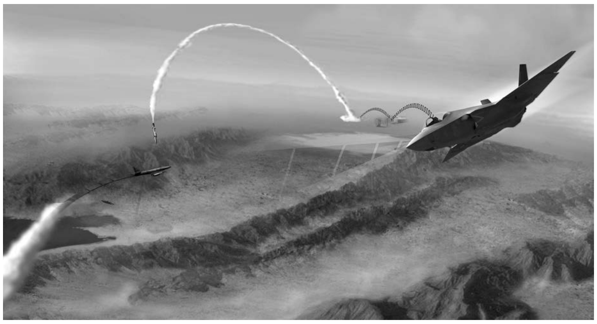
Table provided courtesy of Bruno Huriet from *Seaforth World Naval Review 2018*.

Into the Future

It is evident from this short summary that warship design has changed significantly over the last quarter of a century. Some of these changes, such as size and stealth, are readily apparent. Others, including changes in combat and platform management architecture, are less visible but still fundamental. The extent to which many of the changes have been interconnected is a particularly interesting feature.

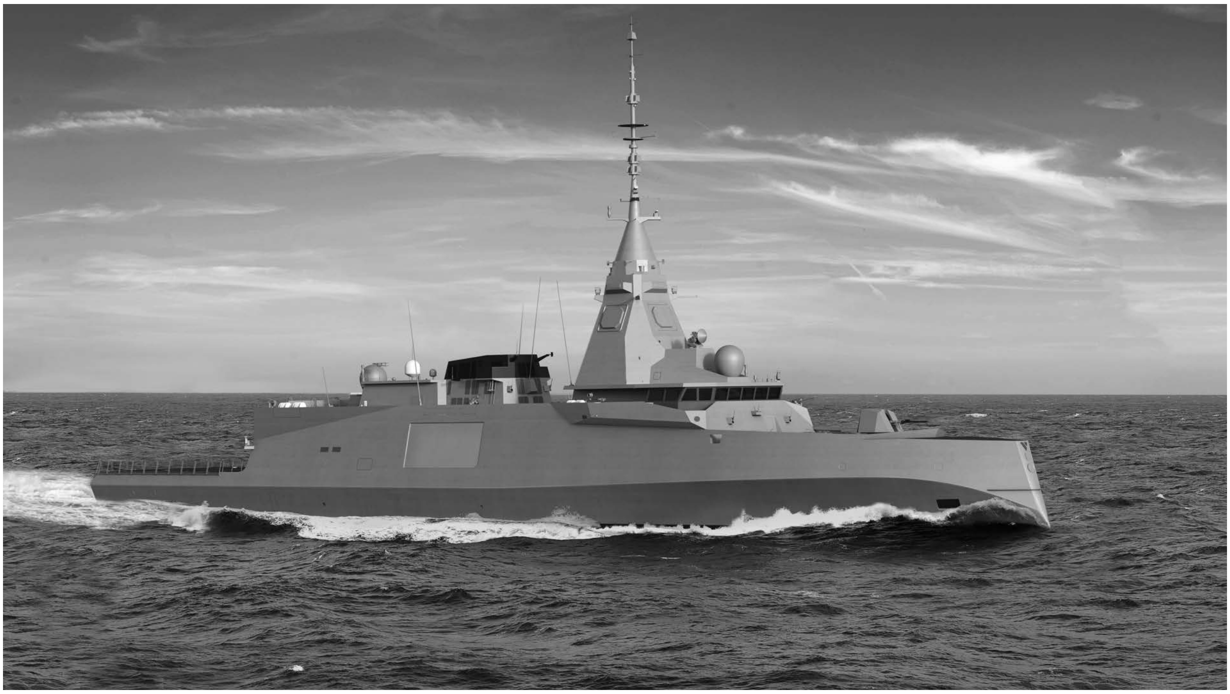
Looking to the future, it seems likely that this rapid pace of change will continue. Future predictions are always fraught with hazard. At one time it was thought that new hull forms such as trimarans would feature prominently in future warship design. Although there are some interesting developments with respect to new bow forms, the US Navy's *Independence* (LCS-2) class currently remains the only larger warship type to take this direction. However, some current trends do seem clearer than others. In particular, the following three factors seem likely to figure highly among those exerting an increasing influence on future warship design:

Networked Combat Capabilities: The ability of warships to share information to create a common command picture is nothing new, with current capabilities tracing their origins to the introduction of tactical data links from the late 1950s onwards. These links allowed the information gleaned from the sensors on different warships and aircraft to be netted together into a combined plot. However, they lacked the granularity and timeliness to allow the shared data to be automated into an individual ship's fire control solution. This ability has arrived with the US Navy's development of cooperative engagement capability (CEC), a system that creates an identical, real-time picture of the battlespace of sufficient quality for fire control purposes in every connected unit. CEC achieved initial operating capability in 1996, and became widely deployed on US Navy Aegis-equipped ships in the first decade of the current millennium.



A graphic demonstrating the basic concept behind the US Navy's Naval Integrated Fire Control-Counter Air (NIFC-CA) system, a form of cooperative engagement capability. Although the graphic illustrates a firing from a land-based test facility, the technology would, for example, allow a warship to engage threats beyond its own radar horizon. (US Navy)

The future is likely to see two main developments. To date, CEC has been a US Navy preserve but other navies are now starting to develop the capability. Australia's



Surface combatants are now being designed with a variety of new – or at least resurrected – bow forms, as illustrated in this graphic of France's new FDI. However, previous expectations that multi-hulled vessels might prove popular have largely failed to materialise, the US Navy's *Independence* (LCS-2) class being one major exception. (Naval Group) new Aegis-equipped *Hobart* class destroyers have already undertaken a series of CEC trials, while the Indian Navy's Project 15A destroyers *Kochi* and *Chennai* undertook a successful test firing using their own indigenous system in conjunction with Israeli Barak 8 missiles in May 2019. Looking ahead, it seems CEC is likely to become a standard fit on many front-line combatants, greatly increasing combat utility. CEC is also likely to develop in sophistication, feeding into a distributed concept of maritime operations under which widely dispersed networks of combatants and sensors operate as an integrated whole. One early example of the direction of travel is the American Naval Integrated Fire Control-Counter Air (NIFC-CA) system. This, for example, allows a ship to engage threats beyond its own radar horizon by using data gathered by a networked aircraft.

Unmanned and Autonomous Vehicles: A key element of the shift towards networked distributed maritime operations is the growing use of various forms of unmanned vehicle. Again, the use of unmanned systems at sea has a long history. Such technology has gained a particularly strong niche in the area of mine countermeasures. Looking forward, unmanned maritime systems are likely to have an increasingly universal presence, having particular utility as sensors and communications hubs in the networked battlefield.

A prototype LaWS laser weapon systems on a trial installation on board the US Navy destroyer *Dewey* (DDG-105). It seems likely that the next decade will see lasers increasingly installed in surface combatants. (US Navy)

There are two implications for warships. First, surface combatants will be required to house and deploy an increasingly varied selection of unmanned systems, as demonstrated by the various mission bays and 'flex decks' already discussed. However, a more significant development will be the advent of unmanned surface warships: vessels that are intended for direct deployment from their own bases that will perform missions currently assigned to their manned counterparts. The US Navy already plans to order ten large unmanned surface vessels over the next five years as concept demonstrators. Displacing in the order of 2,000 tonnes these are expected to be equipped with Aegis and be capable of embarking a range of sensor and weapon payloads. The first vessels are likely to be optionally manned to ease their introduction into service. However, later ships are likely to use artificial intelligence for semi-autonomous or even fully-autonomous operation. The deployment of autonomous naval vessels is not without its hurdles and an autonomous test bed, *Sea Hunter*, is already in use to iron out some of these challenges.

New Weapons Systems: Completing the trio of changes likely to impact tomorrow's surface combatants is a new generation of weapons systems. Foremost amongst these are lasers and railguns. A prototype Laser Weapon System – the AN/SEQ-3 LaWS – suitable for use against drones and other small targets has already been deployed operationally on the US Navy's former interim afloat forward staging base *Ponce* (AFSB(I)-15). Higher-power systems that could destroy a broader range of targets are under development. The US Navy has also funded prototype programmes for electromagnetic railguns that would be particularly well-suited for shore bombardment. However, this technology is somewhat farther away from deployment. Both systems offer significant potential in terms of cost and magazine capacity compared with more traditional missiles. It seems that lasers, in particular, are likely to be an increasing factor influencing warship design.

The history of warship development and design has always been marked by constant change and improvement. This is no less likely to be the case in the decades ahead.

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Endnotes:

[1] It has been estimated that only around one third of a warship's total through-life cost relates to initial design, production and outfitting; maintenance, personnel, fuel and other consumable costs account for the balance.

[2] One apparent exception is the Russian Navy, which continues to commission numerous small but heavily-armed surface combatants capable of undertaking long-range strike missions from littoral waters. Notably, the installation of long-range 'Kalibr' cruise missiles in vessels as small as the 950-tonne Project 21631 'Buyan M' class and 800-tonne Project 22800 'Karakurt' missile ships provides the punch of a major surface combatant in a diminutive hull. This approach is probably reflective of distinct Russian strategic and industrial considerations. Moreover, there are some signs that the development of containerised versions of these missiles could put upwards pressure on this particular philosophy.

[3] This has sometimes been achieved by the age-old 'fitted for but not with' approach, necessitating sufficient space to be reserved for contingent equipment such as additional vertical-launch missile silos. Designing a common hull that can be optimised towards particular mission functions has been another design practice adopted, for example, with the Franco-Italian multi-mission FREMM frigates. A consequence is that the hull has to be large enough to meet the most volume-intensive requirement.

[4] Waterline exhausting has been common in fast attack craft but is relatively rare in larger surface combatants.

[5] Active phased array technology is particularly suitable for low detectability, as its individually-energised transmit/receive modules can generate multiple beams to allow rapid, wide area (volume) searches.

[6] The US Navy has now decided to assign its littoral combat ships to divisions focused on a specific mission. These will be semi-permanently equipped with the relevant equipment and personnel. However, this negates much of the adaptability inherent in the original concept.

[7] As Thales owns 25% of Naval Group, it seems likely there was some degree of collaboration between the two companies with respect to the PSIM design. A practical benefit of the integrated mast approach has been the ability to focus much of a warship's more sophisticated technology in this one module, facilitating overseas assembly of the rest of the ship.

[8] Diesel engines running at very low load have relatively higher fuel consumption to provide a given level of output compared with engines running at higher loads. Using the main engines both for propulsion and for onboard 'hotel' power generation requirements therefore generates efficiencies.

[9] The Type 45 destroyers are scheduled to receive additional diesel generating capacity under a Power Improvement Project to enhance the IEP system's resilience.

[10] Among the major classification societies involved in establishing warship design and construction rules are the American Bureau of Shipping (ABS), France's Bureau Veritas, Italy's RINA, Norway's DnV GL (formerly Der Norske Veritas) and the UK's Lloyd's Register.

THE FLEET BATTLESHIP *CHARLES MARTEL*

Charles Martel was the first of a series of five battleships, all of different design, which subsequently became known as the 'fleet of samples' (*flotte d'échantillons*). **Philippe Caresse** takes a detailed look at the complex design process, then at the technical characteristics and service career of the ship herself.

Following the Franco-Prussian War of 1870–71 and the failure of the French Navy to have any impact on the conflict, there were numerous critics who declared that the death of the battleship was inevitable. The threat from Britain, France's traditional rival, was now regarded as secondary; the primary adversary was now Germany. Thus the naval budget was slashed by a quarter in favour of the Army. Moreover, it was considered impossible to match the Royal Navy, particularly in the construction of battleships. French naval thinking was now firmly under the influence of the *Jeune Ecole*, and was reflected in the statement by Admiral Touchard that:

> 'Battleships of 10,000 tonnes, 100 metres long, and costing 10 million francs, can now be sunk by a single torpedo!'

The *Jeune École*, fronted by the influential Admiral Aube, proposed relegating these 'armoured monsters' to the status of floating batteries for harbour defence, and to reconstitute the Navy as a force of torpedo boats and fast cruisers. By 1892 no fewer than 220 torpedo boats had been constructed and distributed around the French coast and the colonies.

Despite this, to follow the construction of the battleships *Neptune, Marceau* (both laid down 1882) and *Magenta* (LD 1883), the Navy Minister of the day, Vice Admiral Jean Bernard Jauréguiberry, proposed the completion of two new battleships armed with four 34cm (13.4in) guns in two midships turrets disposed *en echelon*, as in the Italian *Duilio* and the British *Inflexible*. His directive of 10 March 1882 informed the *Conseil des Travaux* that the design of these ships was to be assigned to the naval architect Louis de Bussy. After various interruptions and changes to the programme, including a complete halt to battleship construction imposed by Aube himself when he became Navy Minister in January 1886, only the battleship *Brennus* was completed, and to a much-modified design.

During this same period, French naval policy drifted and wavered; between the departure of Aube on 30 May 1887 and the appointment of Senator Edouard Barbey on 10 November 1889 there were no fewer than five Navy Ministers. Against this chaotic background Barbey embarked upon studies for a new programme of 1st class battleships. General characteristics were to be as follows:

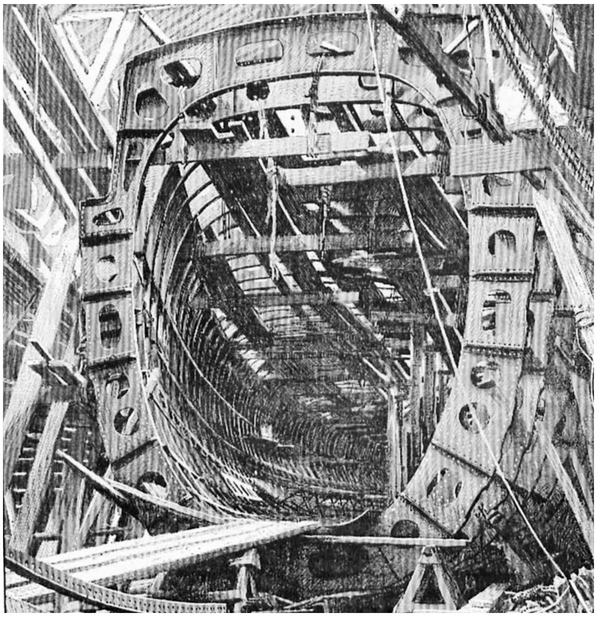
Displacement: 14,000 tonnes maximum.
Armament: Two 34cm Model 1887 guns disposed in single turrets fore and aft, and two 27cm Mle 1887 guns in barbettes amidships; eight 14cm quick-firing (QF) guns; and multiple 47mm and 37mm anti-torpedo boat (ATB) guns disposed around the superstructures and on two military masts.
Protection: A 450mm armour belt with an overall height of two metres, 0.5m being above the waterline.
Propulsion: Two-shaft propulsion machinery capable of 17 knots with natural draught and an endurance of 4,000nm at 10 knots.
Complement: 650 men with 20 days of water and provisions for 60 days.

A project for a battleship in excess of 14,000 tonnes was duly submitted to the Minister on 18 January 1890. This figure provoked vehement opposition from the partisans of the *Jeune École*, who seized on the prohibitive displacement of 'Barbey's monsters'. In the face of public opinion, which was mobilised by the Press, on 24 January Barbey requested new studies for battleships with a maximum displacement of 11,000 tonnes armed with four 27cm guns. The *Conseil des Travaux* was of the opinion that such an armament was insufficiently powerful for a 1st class battleship, particularly in the light of developments on the other side of the Channel. An alternative solution was proposed by the *Directeur du Matériel*, Arthur Bienaymé, on the advice of General du Pan: in a further meeting that took place on 12 June Bienaymé proposed replacing the 34cm guns fore and aft by a newly-developed 30cm gun. The latter was capable of penetrating armour plates 450mm thick at a range twice that of the 27cm gun. Provided some sacrifices were made in protection (as suggested by the Minister in his note of 23 January), displacement could be kept to 11,800 tonnes. The naval programme of 1890, which included four of the new battleships, was duly submitted to the *Conseil des Travaux*, which approved it on 29 August 1890.

The programme did not proceed entirely without

Table 1: **General Characteristics**

Length oa	121.59m
Length wl	119.69m
Length pp	115.49m
Beam (wl)	21.71m
Depth of keel	7.80
Draught	7.60m fwd, 8.40m aft
Freeboard forward	6.36m
Normal displacement	11,839 tonnes
Full load displacement	12,145 tonnes
Surface of underside	3,538m2
Complement	651 officers & men as private ship 751 officers & men flagship



Charles Martel being assembled on the slipway. Note the continuous frames forming a ring around the lower hull and extending up as far as the armoured deck. (DR)

opposition. The adherents of *Jeune Ecole*, objecting to the elevated displacement of the new ships, again exerted their influence, and on 28 January 1891, the Minister directed Charles Huin, responsible for the design of the first ship, *Charles Martel*, to study the characteristics of a battleship of reduced displacement; this was to become the *Bouvet*.

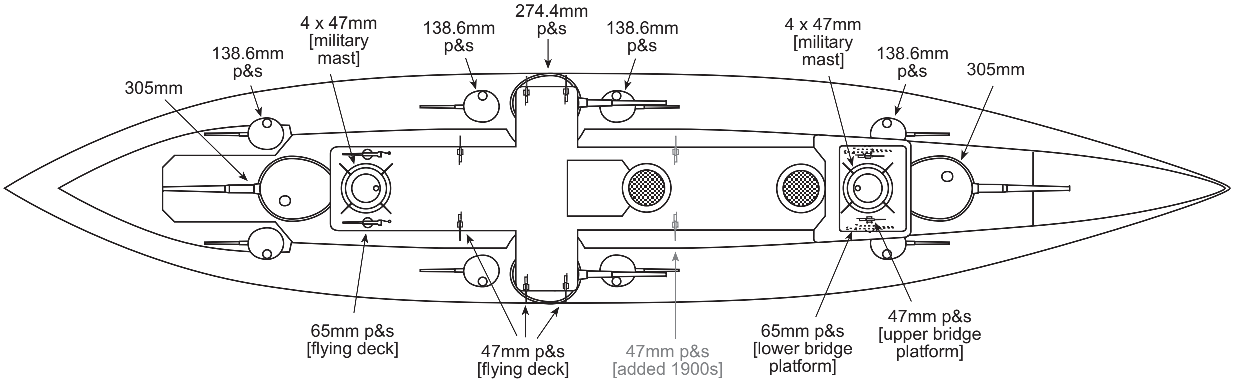
In order to pacify the prominent French naval architects of the day, five were invited to submit proposals. The result was a group of ships subsequently christened the 'fleet of samples' (*flotte d'échantillons*) that conformed in most respects to the staff requirements laid down by the *Conseil des Travaux* but had different dimensions and external/internal layouts. One feature they did have in common was a hull-form with pronounced tumblehome, which gave the ships a steady roll favourable to gunnery, albeit at the expense of stability, and ensured favourable arcs for the wing guns. The battleships *Charles Martel*, *Jauréguiberry*, *Carnot* and *Masséna* would be followed by *Bouvet*.

Charles Martel

Charles Martel was the first of the series of battleships built under the 1890 naval programme. The construction of the ship was supervised by the engineers Vermand and Callou. The hull plating and frames were of steel, with thirteen watertight transverse bulkheads. One noteworthy innovation was that the frames were extended upwards as far as the armoured deck to form a ring around the lower hull.

The main belt (*cuirasse épaisse*) was in part of hammered compound armour and partly of nickel steel. It was manufactured by the Schneider company under a contract dated 30 September 1891. The plates were 450mm thick amidships, reducing to 350mm forward and 310mm aft. The lower edge of the belt varied in thickness from 250mm amidships to 170mm at the outer ends. The height of the belt was 2.00m forward and amidships, reducing to 1.80m aft. Above the main belt there was a strake of light plating (*cuirasse légère*), which was provided by the Guérigny works. The armoured

***Charles Martel:* Layout of Guns 1897**



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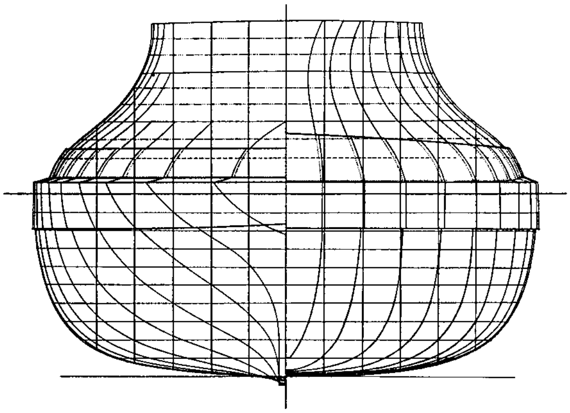


Body Plan of *Charles Martel*

deck was a mix of iron and steel; thickness was 70mm with 100mm on the slopes.

The conning tower, which weighed 55.57 tonnes, had walls 230mm thick, and the communications tube comprised hoops of 200mm nickel steel. When the ship was first completed, the navigation bridge was forward of the conning tower; in October/November 1901 it would be relocated to the platform above.

The total weight of armour was 4,569.18 tonnes.

ARMAMENT

Charles Martel was armed, like her four half-sisters, with two 305mm 45-calibre Mle 1887 guns and two 274.4mm 45-calibre guns, also Mle 1887; the guns were on trunnion-type mountings of identical design, with recoil cylinders and recuperators. All four guns were in enclosed single turrets, disposed in the traditional French 'lozenge' arrangement.

The 305mm turrets were built by Schneider under a contract dated 17 February 1892. They were trained hydraulically; a steam heating system was fitted between December 1897 et January 1898 to prevent the hydraulic fluid from congealing. There were armour plates 370mm thick on the turret walls; the roof, which was of layered plating, and the armoured hood, which was of cast steel, were both 70mm thick; the barbette was protected by 320mm plates of nickel steel. Each turret weighed 93.7 tonnes. The 274.4mm turrets had the same thickness of armour and weighed 79.10 tonnes. A new type of optical sight was fitted in the turrets for the main guns in March 1907.

The 138.6mm turrets had 100mm walls and 20mm plating on the roof. Like the main turrets, they were built by Schneider under a contract dated 17 February 1892. Each turret weighed 11.21 tonnes; new optical sights were fitted in December 1907.

The total weight of protection for the guns was 1,525.92 tonnes.

In addition to the turreted guns there were four of the latest 65mm Mle 1991 QF guns on open mountings at

Table 2: **Armament**

Two 305mm 45-cal Mle 1887 BL guns in two single turrets
Two 274.4mm 45-cal Mle 1887 BL guns in two single turrets
Eight 138.6mm 45-cal Mle 1888–91 QF guns in eight single turrets
Four 65mm 50-cal Mle 1891 QF guns in open single mountings
Sixteen 47mm 40-cal Mle 1885 QF guns in open single mountings
Five 37mm 20-cal Mle 1885 revolver cannon
Four 450mm torpedo tubes

Calibre	**Shell weight**	**Muzzle velocity**	**Firing cycle**
305mm	292kg*	815m/s	1rpm
274.4mm	216kg*	815m/s	1rpm
138.6mm	35kg	730m/s	4rpm
65mm	4kg	715m/s	8rpm
47mm	1.5kg	650m/s	9–15rpm
37mm	0.5kg	435m/s	20–25rpm

* Cast Iron (CI) shell

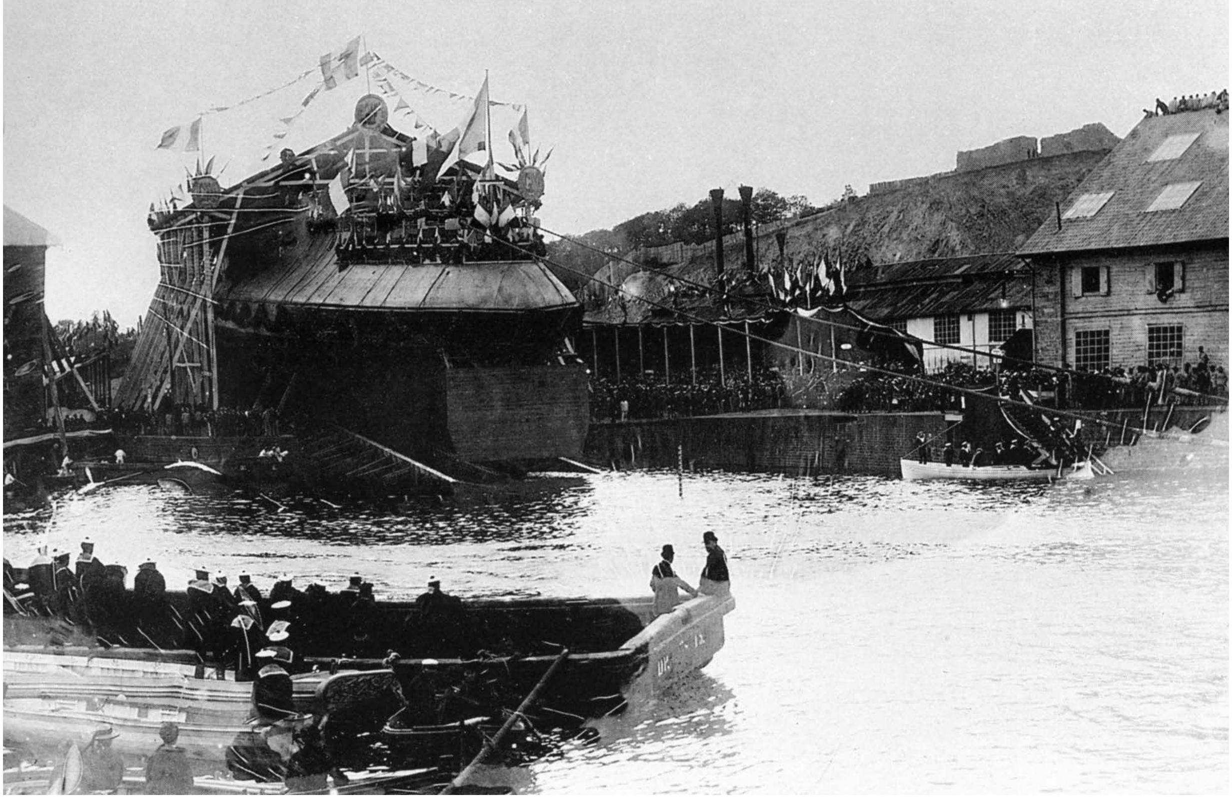
Calibre	**Angle of elevation**	**Range**
305mm	+10°/-5°	12,500m
274.4mm	+10°/-5°	11,800m
138.6mm	+15°/-5°	9,400m
65mm	+20°/-15°	5,400m
47mm	+20°/-20°	4,000m
37mm	+20°/-20°	2,000m

Machinery

Boilers	24 Lagrafel & d'Allest
Engines	two Schneider VTE
Propellers	two 3-bladed 5.7m
Rudder	non-balanced, 23.30m^2
Designed power	13,070CV
Power on trials	14,997CV
Maximum speed	18.13 knots
Coal	908 tonnes
Endurance	4,462nm at 8.35kts 2,218nm at 13.81kts 863nm at 18.13kts

Equipment

Searchlights	six 60cm Mangin B 75A projectors
Boats	two 10-metre steam pinnaces one 11-metre pulling pinnace one 10.5-metre pulling cutter one 10-metre pulling cutter two 9-metre pulling cutters three 8.5-metre whalers one 8-metre whaler one 7-metre whaler two 5-metre dinghies two 3.5-metre punts two 5.6-metre Berthon canvas boats
Anchors	two Marrel 13.1-tonne bower anchors one 5.26-tonne sheet anchor two 3.61-tonne kedge anchors



The launch of *Charles Martel* at Brest on 29 August 1893. (Musée de la Marine)

the four corners of the ship, sixteen of the standard Hotchkiss 47mm Mle 1985 anti-torpedo boat (ATB) guns, and five 37mm revolver cannon. The ship also carried two 65mm Mle 1881 field guns for the landing party.

Charles Martel was equipped with four tubes for 450mm torpedoes, two of which were fixed and two trainable. The two fixed submerged tubes were located at the lower platform level, 3.64 metres below the waterline in the compartment for the capstan motor, and were mounted at 90 degrees to the ship's axis. The above-water tubes were trainable between 30° and 110°, and were installed on the main deck immediately abaft the forward 138.6mm turrets. They were 2.2 metres above the waterline and were suspended from rails that allowed the tubes to be elevated or depressed by 2 degrees.

The torpedo was the Mle 1892, a Whitehead torpedo built under licence at Toulon. It had a length of 5.05m; weight was 530kg including a 75kg explosive charge, and it had a range of 800m at 27.5 knots. Twelve torpedoes were carried.

FIRE CONTROL

The conning tower had fire control tables port and starboard for the torpedo tubes. Communication with the torpedo compartments was by voice-pipe, with a bell for firing orders.

Two of the six 60cm Mangin searchlight projectors were mounted on fixed pedestals on the upper platforms of the two military masts (*ligne haute*). The four lower projectors (*ligne basse*) were on mobile carriages behind ports in the upper hull. All the projectors were controlled remotely via electric cables

In January 1900 a Gaillard telephone system was installed to connect the conning tower with the *Poste Central* beneath the armoured deck and the turrets. In June 1901 a W/T office was installed on the flying deck on which the light guns were mounted; it was relocated beneath the armoured deck in August 1904.

In December 1907 a 2-metre Barr & Stroud pedestal rangefinder was mounted atop the navigation bridge. A centralised fire control system was installed in the conning tower, with secondary FC positions in each of the 305mm turrets. In 1909 a second Barr & Stroud rangefinder was embarked and the rangefinders moved to the flying deck forward of the first funnel.

MACHINERY

Steam for the main engines was supplied by 24 boilers of the Lagrafel & d'Allest type built by Fraissinet & Cie, which were mounted back to back on either side of the centreline and distributed between six boiler rooms. Each of the boilers had a single rectangular furnace, and maximum pressure was 15kg; steam was first raised on 28 May 1895. There were eight vertical ventilators for the boiler rooms each with a capacity of 50,000m^3 per hour. The two identical funnels housing the uptakes for the boiler exhausts each had a cross-section of 15.28m^2 and a height of 22.40m above the gratings.

The boilers supplied steam for two vertical triple-expansion (VTE) engines built at Le Creusot using plans provided by Schneider; the contract was dated 26 August 1891. Assembly on board began in February 1894 under the supervision of engineers (*chefs monteurs*) Coureau and Pocheron. The engines were installed side by side in two independent engine rooms divided by a centre-line bulkhead. There were four ventilators for the engine rooms each with a capacity of 25,000m^3 per hour.

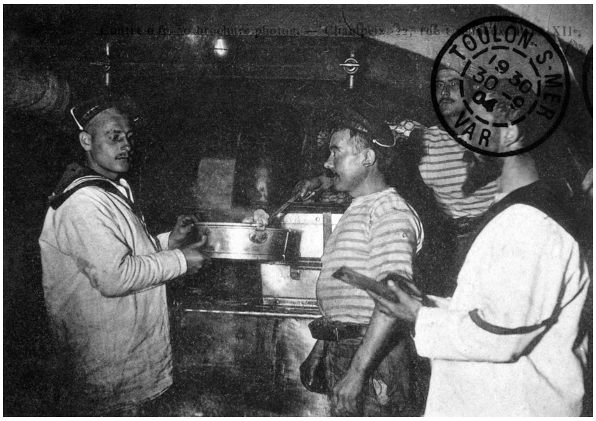
The two outward-turning propellers were of aluminium bronze. The turning radius of *Charles Martel* was approximately 400 metres. At the maximum speed of 18.13 knots the angle of heel was 6 degrees; at 16 knots it was 2.5–3.5 degrees.

There were four main Thirion bilge pumps each rated at 1,000 tonnes per hour, two Thirion No 6 pumps rated at 45 tonnes per hour, and two Thirion No 5 pumps with a capacity of 30 tonnes per hour. In January 1900, the outlets for the Thirion 1,000-tonne pumps were lowered.

Electrical power for the ship was supplied by four dynamos built by the Société Alsacienne de Construction Mécanique; each was rated at 600A and served an 83-Volt circuit. A comprehensive steam heating system for the accommodation spaces was supplied by the Leroy company of Paris.

EQUIPMENT

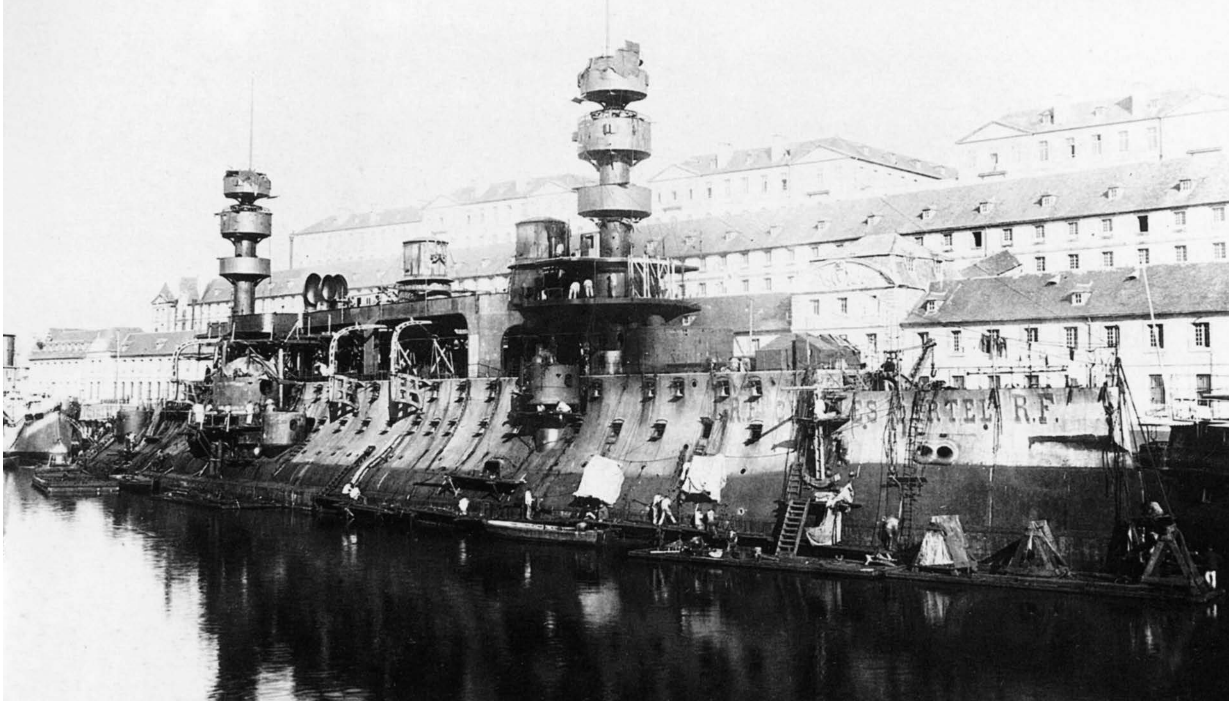
The two 10-metre steam pinnaces, which doubled as torpedo launches, could be armed with a a 37mm QF gun, a searchlight projector and a Flèche-type torpedo launching system. The 11-metre pinnace could likewise be fitted with a 37mm QF gun, and the 10-metre pulling cutter could be equipped with a Coutausse-type torpedo launching system and a 37mm QF gun.



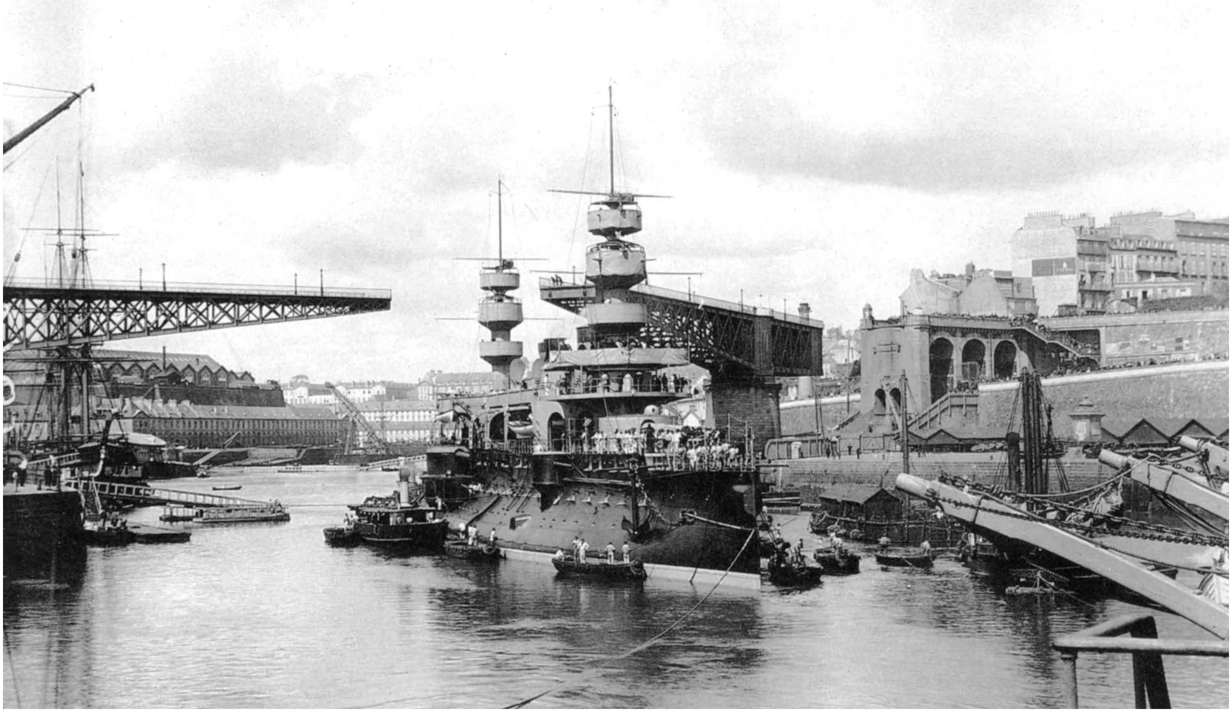
One of the galleys. (Author's collection)

The larger boats were handled by four pairs of heavy lattice-type davits, and there were two pairs of lighter davits for whalers amidships, on either side of the 274mm turrets, and two further pairs for whalers and dinghies close to the stern. Power for handling the boats was provided by two 2-cylinder steam winches supplied by Caillard Bros, each of which was rated at 2,700kg.

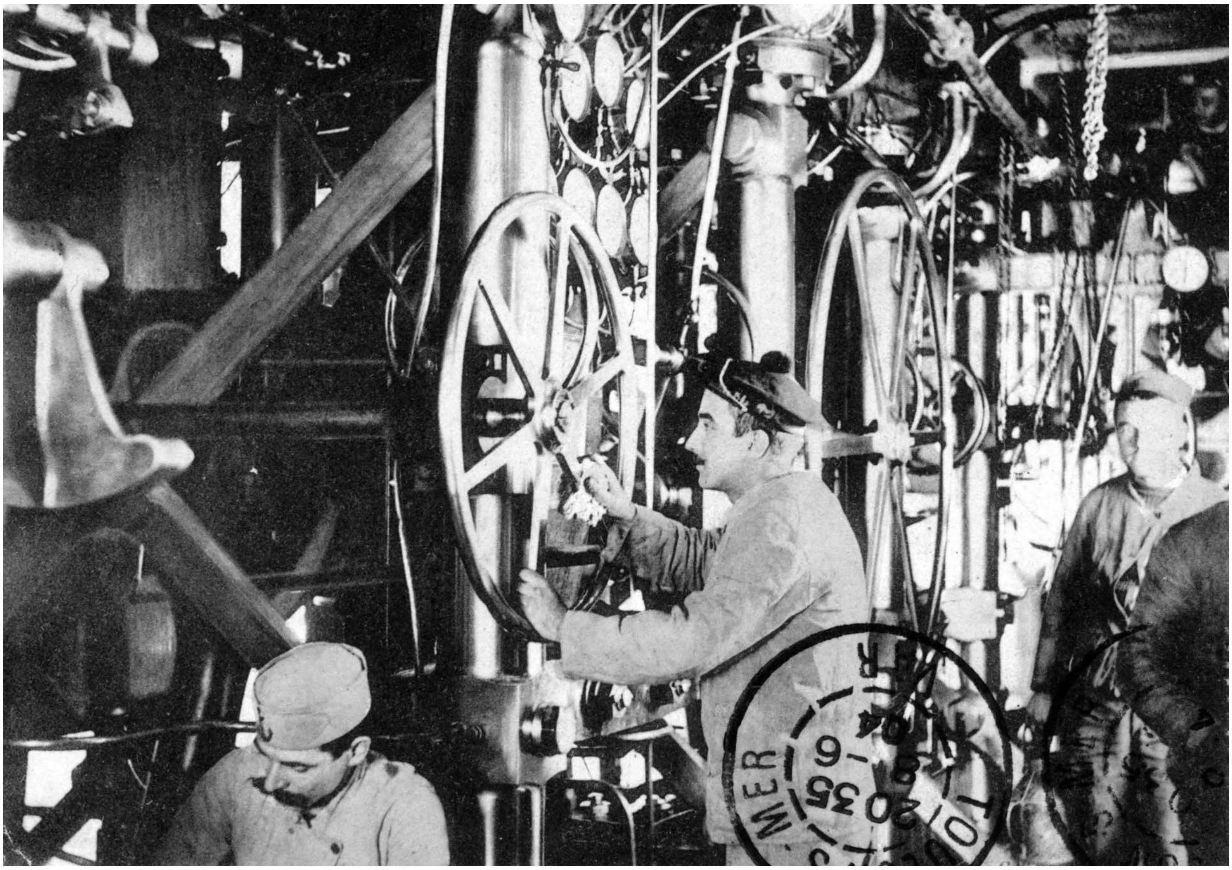
The anchor chains were 60mm in diameter; each had a length of twenty-four 30-metre shackles. The main capstan, which like that of the winches for the boats was a 2-cylinder steam model supplied by Caillard Bros, was



The battleship during fitting out. The guns are not yet in place. (Musée de la Marine)



Charles Martel casting off at Brest for one of her first sorties. Note the swing bridge across the River Penfeld, which in the process of being opened. (Musée de la Marine)



The machinery controls in one of the two engine rooms. (Author's collection) rated at 33,000kg. The auxiliary capstan mounted on the quarterdeck was from Rateau & Sautter Harlé, and was rated at 5,000kg.

There was sufficient stowage for 45 days of provisions for a crew of 721 men; a complete ration was calculated at 1.65kg. A total of 52 tonnes of drinking water was embarked in iron tanks, sufficient for 20 days at sea with a crew of 651. There was also stowage for 24,660 litres of wine, 8,417 of canned meat, twenty-three 0.98kg barrels of salted provisions, 350 20.12kg drums of flour, one hundred 5.2kg containers of biscuit, 3,990kg of vegetables of all varieties, and 1,550kg of coffee, sugar and rice. The galleys were fired by wood; 20 cubic metres were stowed in the wine hold forward.

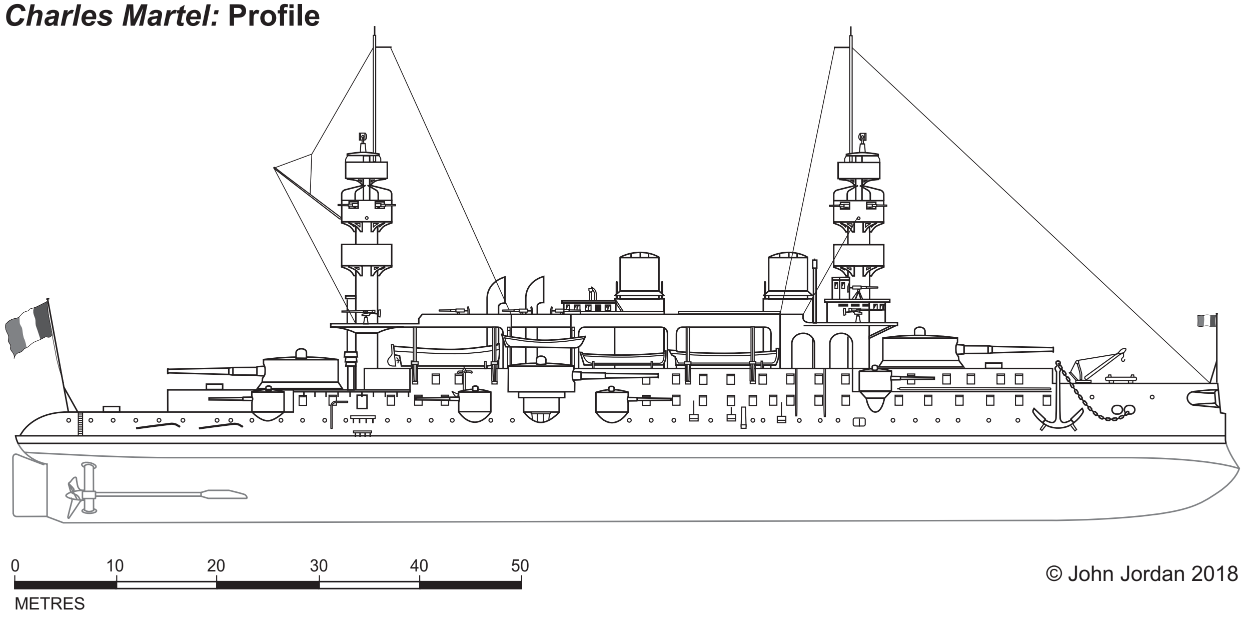
LAUNCH AND TRIALS

Brest Naval Dockyard received the instruction to lay down *Charles Martel* to the plans of constructor Charles Huin on 10 September 1890. She was launched on 29 August 1893, and the journals reported the launch as follows:

> On Tuesday morning, the Minister of Marine visited the defences of Le Goulet, accompanied by the Colonel of Artillery and the Director of Anti-Submarine Defences. In the afternoon he attended the launch of *Charles Martel*, which was celebrated by large crowds and was a complete success. The launch operation was directed by Montchoisy, the engineer responsible for new construction at Brest, and by Callou, the deputy engineer 1st class charged with the construction of *Charles Martel*. Due to the large dimensions of the battleship, there was hardly any gap between the platforms on which the dignitaries stood and the slipway. With only a few remaining props in place the ship created a striking impression; the hull was painted red with the ports picked out in black. The hull was essentially complete and the positions of the guns were indicated by the empty gun-ports of the turrets. The wooden backing for the main armoured belt had been carefully coated with linseed oil. At 3.30pm the skiff belonging to the *Préfet Maritime* came alongside the landing stage, and the Minister of Marine and Admiral de la Jaille disembarked, saluted by a ceremonial armed guard of marines. At 3.50pm the blessing was given by the Chaplain to the Navy, Father Darrieux. The shoring was then removed, and the hull readied for launch.
>
> At the precise moment when the clock of the port chimed 4.30, the proud battleship shuddered into motion and glided majestically into the water, its impetus slowed by the usual impedimenta so as not to impose too much strain on the restraining hawsers. The crowd cheered and the band of the fleet struck up the Marseillaise. The tugs of the Brest port establishment then put lines aboard ready to guide the ship to its berth, but the hull and the landing stage were then besieged by a host of small boats. The *Préfet* became so concerned about possible casualties from the cables and apparatus used for the launch that he ordered the operation to be halted until the boats could be cleared from the area.

Fitting out proved to be a lengthy process (three years), and from September 1893 was supervised by Huin himself. The engines and boilers were embarked from February 1894, the main guns from December of the same year. The boilers were lit for the first time on 28 March 1896, and static trials of the propulsion machinery took place on 24 September. On 10 January 1896 the ship was manned for trials, and the first sortie into the anchorage at Brest, to calibrate the compass, took place on 30 April. The various trials were conducted during the following months, when two 65mm and five 37mm guns were disembarked and replaced by additional 47mm ATB guns.

***Charles Martel:* Profile**



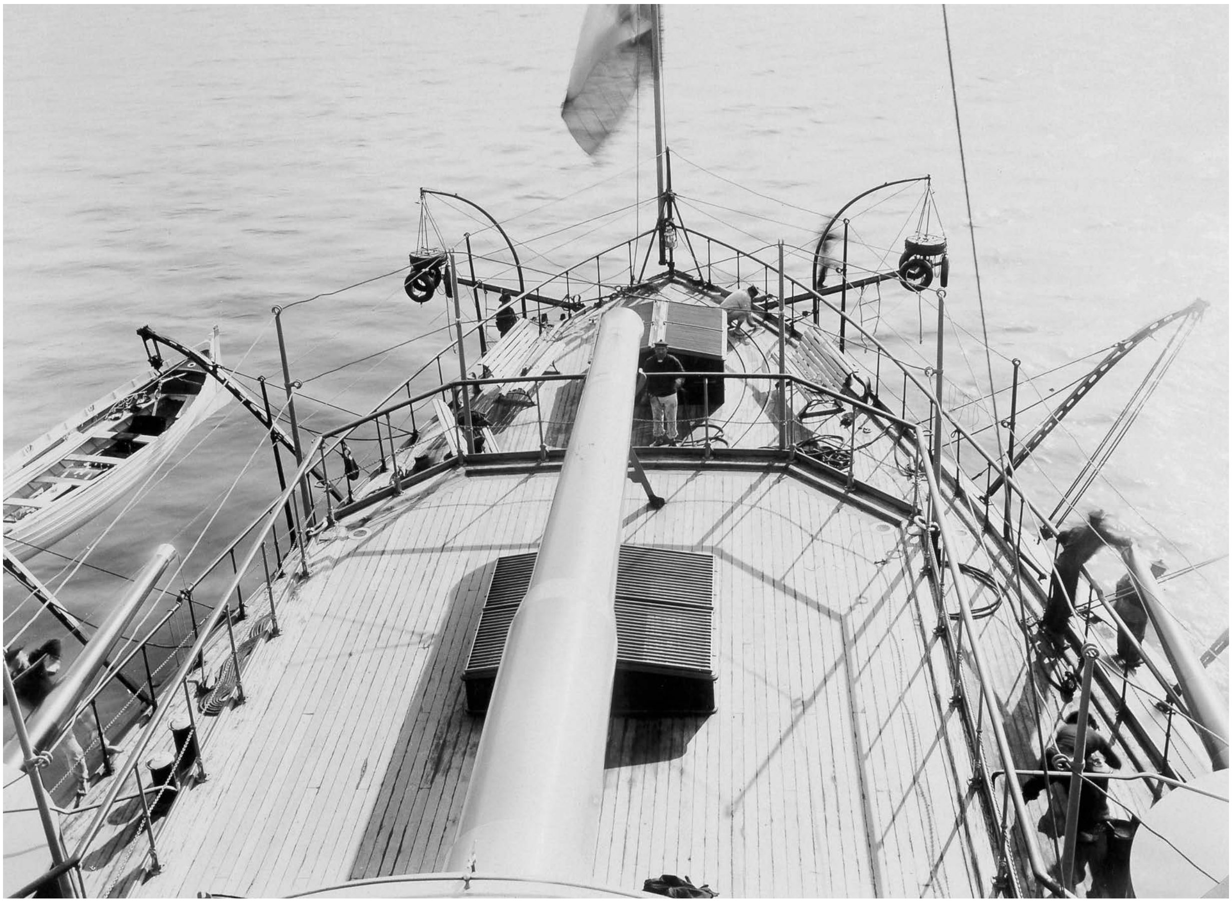
Charles Martel was then temporarily assigned to the Northern Squadron in order to welcome a Russian squadron comprising the imperial yacht *Shtandart* and the auxiliary cruiser *Polyarnaya Svezda* following a visit to Portsmouth. On 5 October Tsar Nicolas II was received in Cherbourg by President Félix Faure, and the festivities concluded with a naval review. *Charles Martel* returned to Brest on the 16th.

On 21 December *Charles Martel* conducted torpedo launching trials in the bay of Bertheaume. When the ship was steaming at 13 knots a slight shock was experienced, quickly followed by a surge in power in the port engine. The battleship proceeded to Brest at reduced speed, and once she was safely moored, two divers inspected the underside of the hull without finding anything in particular. It was only when *Charles Martel* was subsequently docked at Le Salou that it was found that the port-side docking keel had been damaged and the propeller on the same side had a badly bent blade that was found to be irreparable. Following this incident the Prefect ordered a hydrographic survey of these waters that discovered a rock less than two metres beneath the surface in a sea area that had previously been declared free of any risk to navigation.

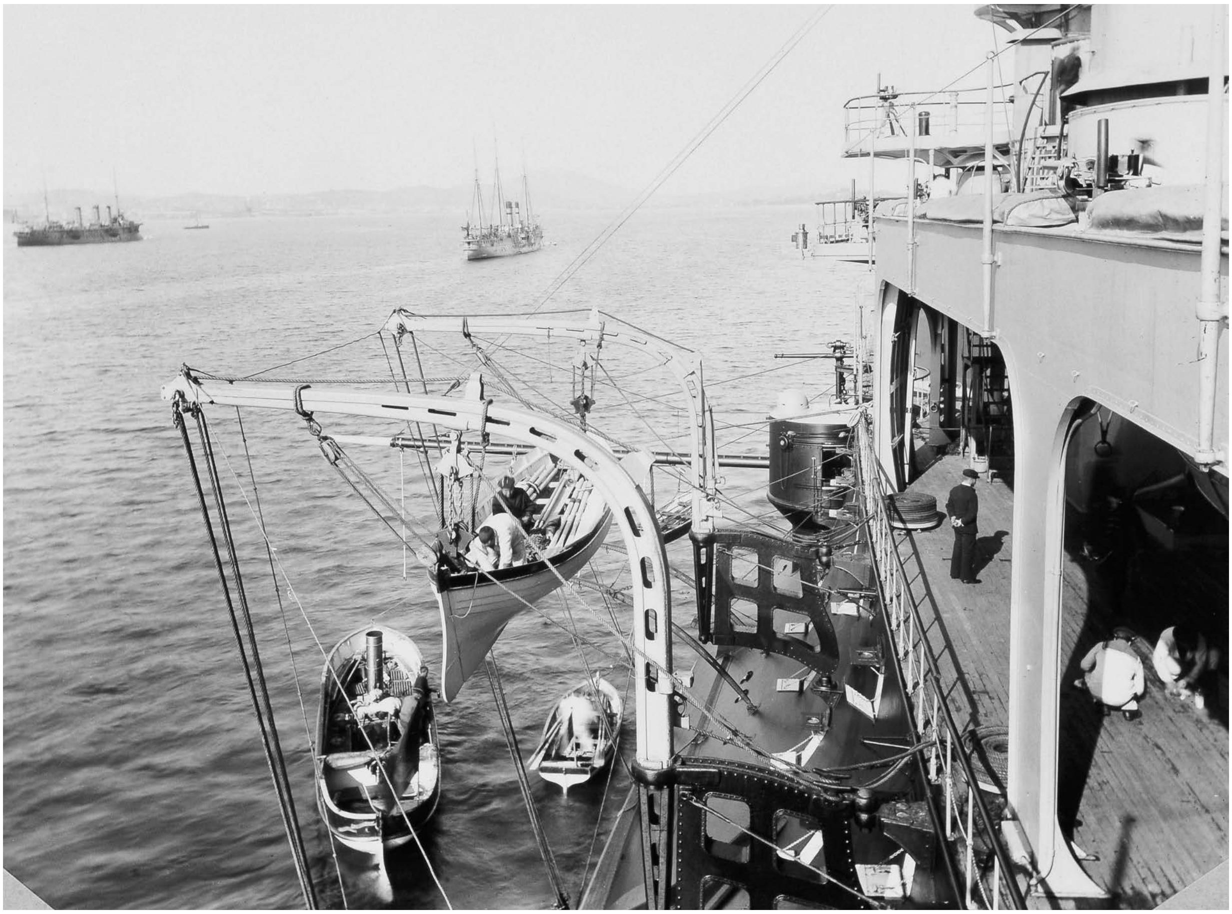
Charles Martel was undocked on 1 February 1897 and, on the 25th, a ministerial directive (DM) announced that the battleship was to be assigned to the Mediterranean Squadron. Unfortunately, on 5 March, in the approaches to Brest, the servo-motor for the rudder declutched itself for no particular reason, and the ship drifted onto the Mengam rock. The only damage was a slight twisting of the ram bow, which was not serious enough to prevent the ship from setting sail for Toulon on 8 March; she arrived on the 15th. The full power trial was conducted on 5 May, when the ship attained a maximum speed of 18.13 knots with 14,997CV.

The report of Captain Rouvier, covering the trials period begun at Brest on 10 January 1896 and concluded at Toulon on 20 July 1897, included the following observations:

> From a sea-keeping point of view: *Charles Martel* should be successful in service. She is fast, holds a stable course, and is particularly manoeuvrable for her size. The internal layout is well designed and spacious, and the accommodation for the crew is of a good standard. The ship has a pronounced roll in a heavy swell such as is experienced in the Atlantic, but the roll is gentle, and the ship is much less susceptible to the shorter waves of enclosed seas. The engines and boilers work well, but it is to be regretted that Le Creusot have used some components that do not respond well to the steam pressures currently available.



A fine view of the quarterdeck with the after 305mm gun in the foreground. (Marius Bar)



A pulling cutter suspended from the forward pair of lattice-type davits. Note the heavy hinged lattice frames at the base of the davit arms, used to take the davits clear of the tumblehome. (Marius Bar)

> From a military point of view: I consider that the overall disposition of the artillery, the adoption of enclosed turrets for all the heavy and medium guns, the grouping of the guns and their wide firing arcs, mean that *Charles Martel* is an excellent combat vessel and constitutes a marked improvement on the older battleships, notably in terms of the protection of the guns and the gun crews, but there remain criticisms. The principal of these concerns the weakness of the medium guns: the eight 138.6mm guns are too small in number and too light in firepower for a ship displacing around 11,900 tonnes. The heavy flying deck on which the light guns are mounted has also been the subject of criticism; its presence is necessary simply because of the disposition of the ship's boats, which occupy the full length of the shelter deck … Other criticisms include the reliance on the absence of manual back-up for the powered machinery, the cramped conning tower, through which the military foremast has to pass, the pipework for the bilge pumps, the outlets for which are above the light armour belt [author's note: they were lowered in January 1900], and the handling arrangements for the torpedoes.

Charles Martel was finally commissioned on 20 February 1897 (DM dated 13 February 1897).

CHARLES MARTEL IN THE MEDITERRANEAN SQUADRON

On 6 August 1897, *Charles Martel* hoisted the flag of Rear Admiral Paul Dieulouard. On 9 September she took part in manoeuvres with the squadron off Golfe-Juan and Les Salins. During gunnery practice with the main guns, problems were experienced with the run-out mechanisms of the forward 305mm and the starboard 274mm guns. These were resolved in October/November. On 29 November a violent gust of wind broke the after topmast, which was temporarily replaced by the foretopmast.

On 29 March 1898, the sloop *Pétrel* was sunk during a gunnery exercise. President Félix Faure embarked for an exercise that took place between 14 and 16 April. There was a visit to Corsica between 21 and 31 May, after which *Charles Martel* took part in the annual grand naval manoeuvres, which began on 8 July. Port visits were made to Bizerte, Philippeville, Bône and Les Salins d'Hyères, and the fleet returned to Toulon on 30 July. From mid-September *Charles Martel* was assigned to the 2nd Division (CA Roustan) with her half-sisters *Carnot* and *Jauréguiberry*; the 1st Division comprised *Brennus* (VA Humann), *Bouvet* and *Masséna*.

From 18 October, tensions with Great Britain were heightened following the Fashoda Incident and the fleet prepared for combat, then sortied to Les Salins d'Hyères. The situation was resolved on 5 November, and *Charles Martel* was docked from the 11th to the 24th of that month.

In February 1899 there were visits to Golfe-Juan and Villefranche. In the anchorage at Villefranche the ships took part in the annual carnival, but the festivities were abruptly curtailed by news of the death of President Faure. In March *Charles Martel* visited Golfe-Juan, Bastia, Bonifacio, Ajaccio and Villefranche. The squadron then anchored off Barcelona, where it received an enthusiastic welcome. After repairs at Toulon in September, *Charles Martel* participated in a sortie to the Levant that began on 11 October with visits to Piraeus, Jounie, Beirut, Jaffa, Haifa, Tripoli, Smyrna, Latakia, Alexandretta, Rhodes, Salonika and Messina; she returned to Toulon on 21 December.

Charles Martel was again docked from 9 January 1900, and the opportunity was taken to re-route the outlets for the bilge pumps, to instal a Gaillard telephone system, to disembark the ammunition cages and hydraulic cranes for the 138.6mm guns and to modify the ventilation system.

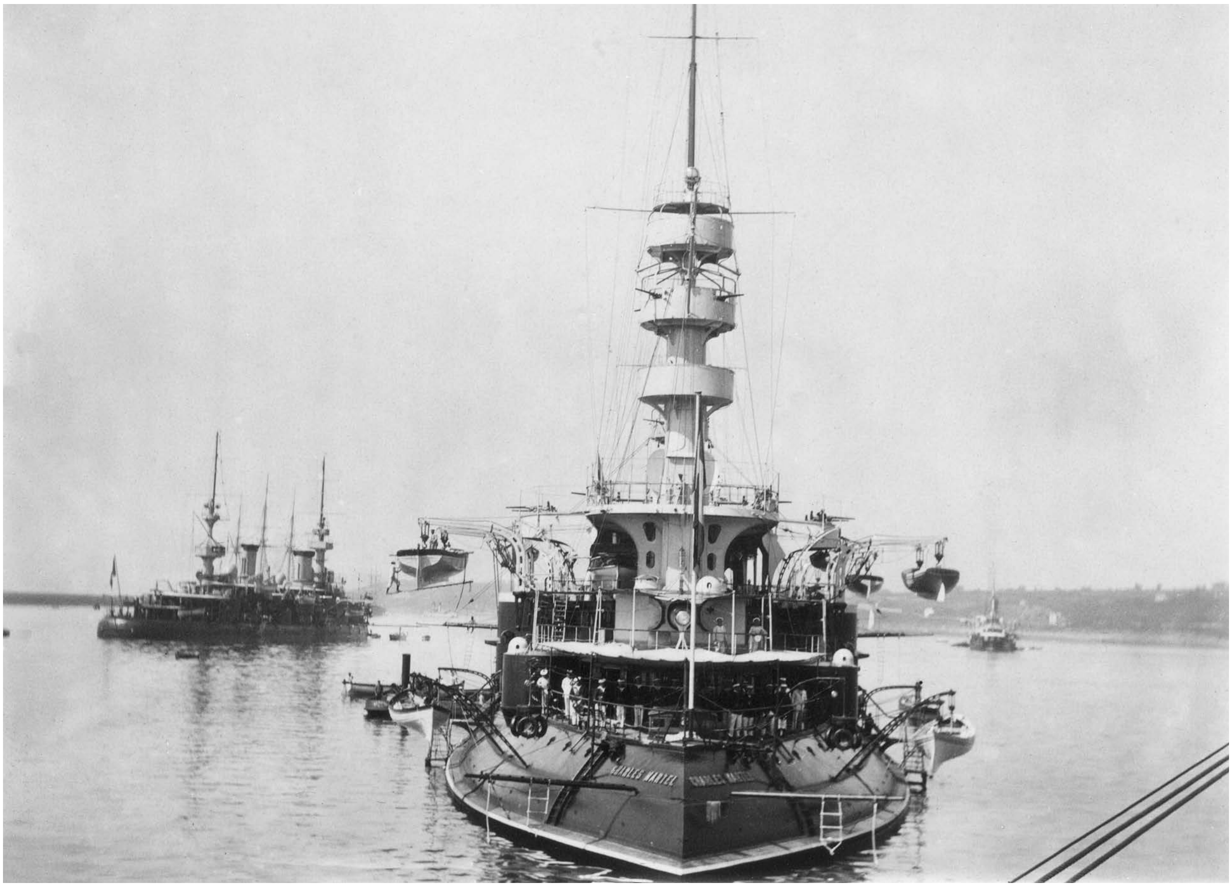
The annual grand manoeuvres began on 21 June, and the Mediterranean Squadron joined with the Northern Squadron in the Atlantic before anchoring at Morgat on 8 July, moving on to Brest and Cherbourg where a naval review took place in the presence of President Emile Loubet. Following a visit to Royan 2–7 August, the fleet headed for Toulon where it dropped anchor on the 14th. During the transit to Toulon, on the night of 10/11 August, the flagship *Brennus* collided with the destroyer *Framée*, which promptly sank with the loss of the commanding officer and 46 of her crew.

On 27 August *Charles Martel* was docked and the servo-motor for her rudder was replaced. The year ended without any notable incident: there was gunnery practice at Les Salins 17–18 October, then a docking from 10 December.

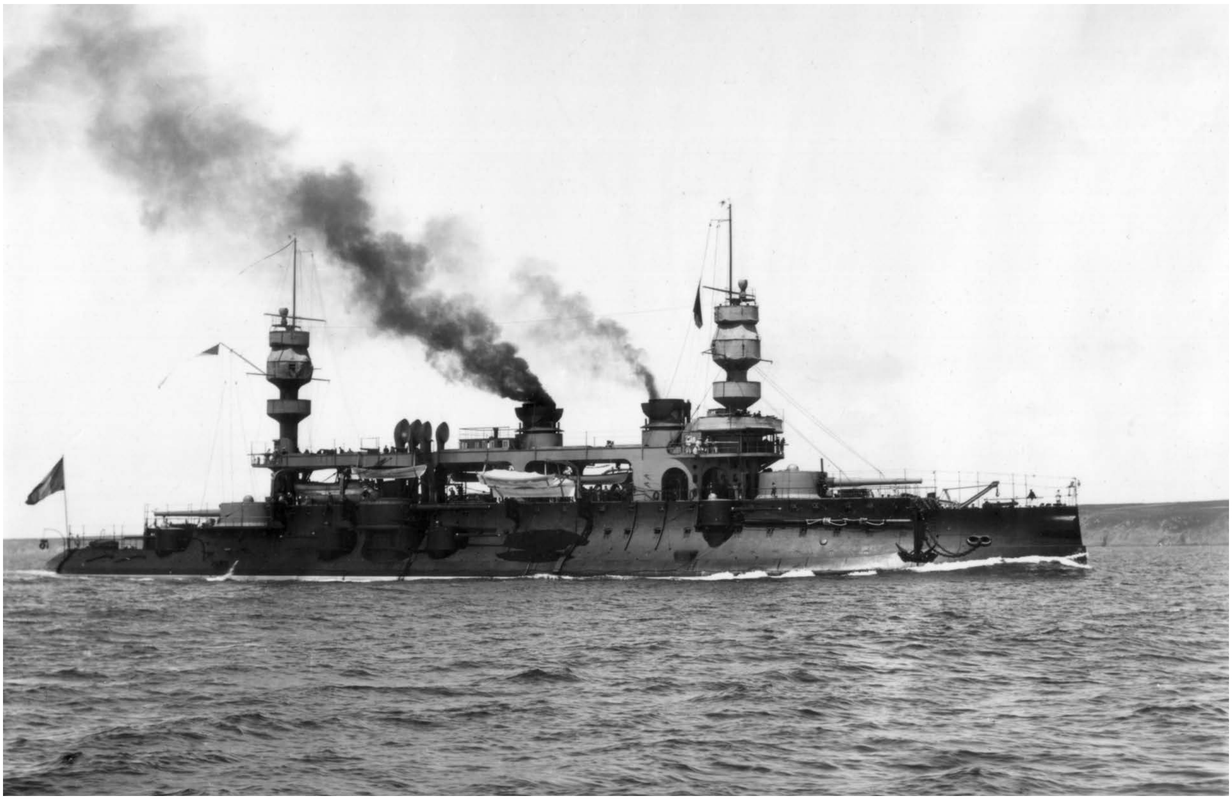
THE 'BIGGEST TARGET IN THE FLEET'

During a general inspection of the ship, Captain Chocheprat noted:

> There would be considerable advantage in reducing drastically the extensive top-hamper that makes the *Charles Martel* the biggest target in the fleet. I suggest the adoption of the simple fore and after superstructures of *Bouvet* … The two prominent military masts contribute to making the ship a huge target; none of our other battleships have such bulky masts.



Stern view of *Charles Martel* at anchor. On the left side of the photo is the battleship *Masséna*. (DR)



Charles Martel in 1897. Note the heavy, hinged funnel caps in the lowered position and the heavy flying deck amidships. (DR)

However, these proposals by Chocheprat were never acted upon, and *Charles Martel* would end her career with her masts and superstructures unmodified.

From 9–11 February 1901 *Charles Martel* visited Ajaccio, and on 10 April she formed part of the escort for President Loubet. The latter, who had embarked on the battleship *Saint Louis,* was sailing from Villefranche to Toulon to welcome an Italian squadron.

Charles Martel conducted exercises at Les Salins during May and visited Corsica from the 18th to the 24th. On 21 June the grand naval manoeuvres took place: the Northern Squadron joined up with its counterpart in the Mediterranean, and the combined fleet made a port visit to Ajaccio. On this occasion France's first operational submarine, *Gustave Zédé*, participated in the exercises. In the early morning of 3 July the fleet was leaving the anchorage when *Zédé* fired an exercise torpedo that struck *Charles Martel*. Despite this undisputed success, Rear Admiral Aubry de la Noé, who had hoisted his flag in the battleship, dismissed it, claiming that 'it was against the rules of the game'. Nevertheless, the submarine's attack had major repercussions, both national and international. The Mediterranean Squadron arrived back in Toulon on 11 July, departing six days later for visits to Port-de-Bouc, Grau-du-Roi, Le Lavandou and Saint-Tropez. During this sortie torpedo boat *104* was employed as a target and sunk by the light guns of the battleship.

Table 3: **Commanding Officers**

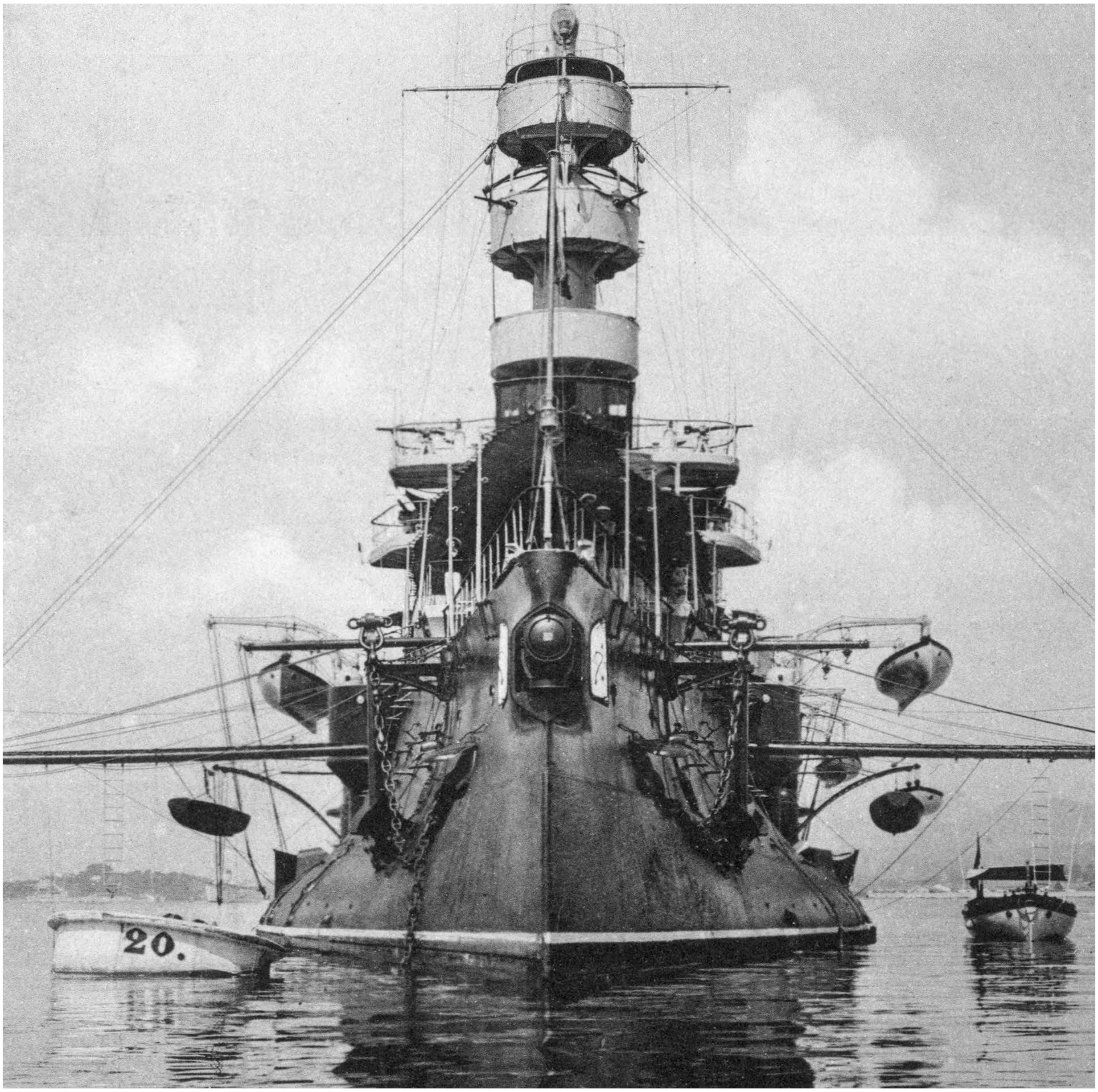
CV Rouvier	10 Jan 1896 – 6 Aug 1897
CV Leygues	6 Aug 1897 – 26 Sep 1898
CV Chocheprat	26 Sep 1898 – 26 Sep 1900
CV Mayel	26 Sep 1900– 15 Oct 1901
CV Voiellaud	15 Oct 1901 – 1 May 1902
CV Pailhes	1 May 1902 – 1 Nov 1903
CV Dufayot de la Maisonneuve	1 Nov 1903 – 1 Nov 1904
CV Campion	1 Nov 1904 – 2 Nov 1906
CV Senès	2 Nov 1906 – 30 Nov 1908
CV Lecourtois	30 Nov 1908 – 30 May 1910
CV Degouy	30 May 1910 – 21 Jul 1911
CV Fournier	21 Jul 1911 – 15 Apr 1912
CV Frot	15 Apr 1912 – 6 Nov 1912
LV Beauge	6 Nov 1912 – 1 Apr 1914
Flag Officers	
CA Dieulouard	6 Aug 1897 – 25 Sep 1898
CA Roustan	26 Sep 1898 – 25 Sep 1900
CA Aubry de la Noé	26 Sep 1900 – 15 Oct 1901
CA Marquis	15 Oct 1901 – 1 May 1902
VA Fournier	24 Apr 1907 – 25 Apr 1907
VA de Jonquières	7 Nov 1908 – 23 Nov 1908
VA Philibert	20 Sep 1909 – 29 Sep 1909
CA Adam	21 Jul 1911 – 25 Feb 1912

Notes:

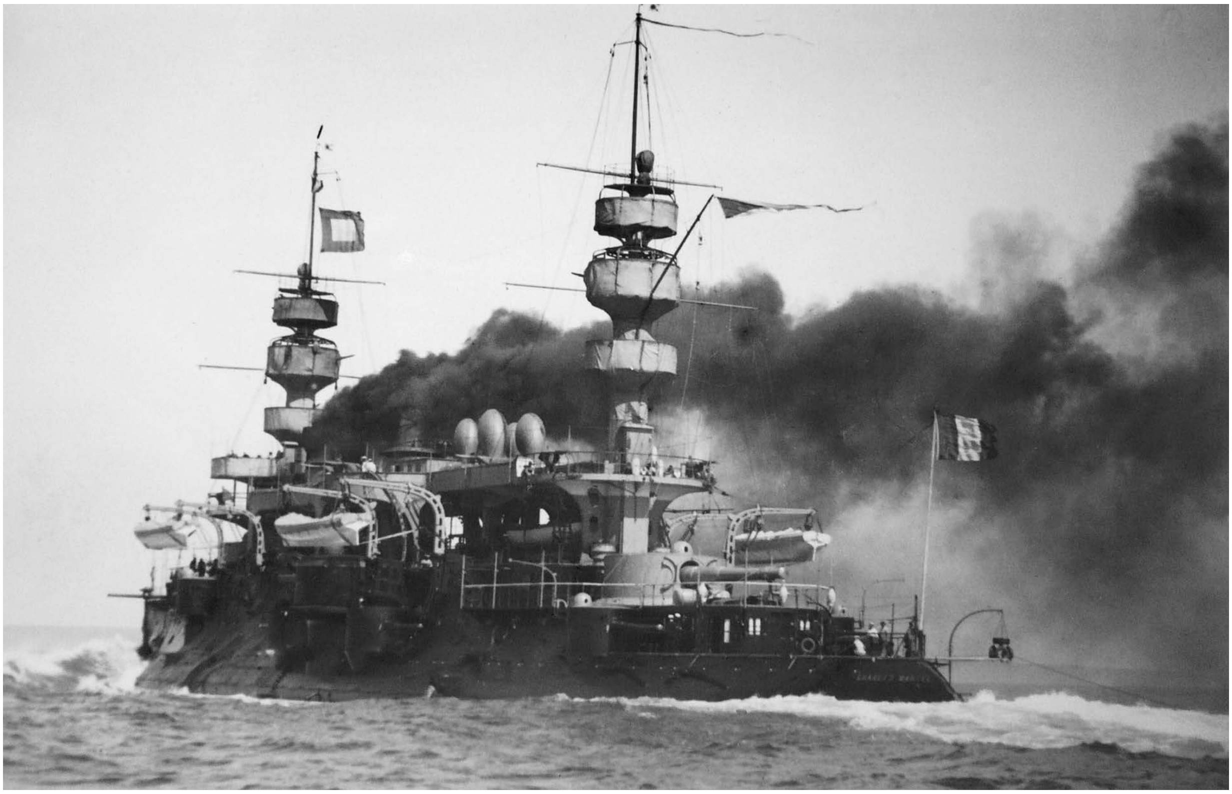
VA	*Vice-Amiral*	Vice Admiral
CA	*Contre-Amiral*	Rear Admiral
CV	*Capitaine de Vaisseau*	Captain
LV	*Lieutenant de Vaisseau*	Lieutenant

On 22 August the 2nd Division (*Charles Martel, Bouvet* and *Jauréguiberry*) sailed for Dunkirk to welcome the Tsar of Russia and his wife. The ships ran into a storm in the Bay of Biscay and sheltered briefly off the Ile d'Aix before arriving at Cherbourg on the 31st. The three battleships sailed with the Northern Squadron on 14 September, arriving at Dunkirk the following day. The welcome accorded to Nicholas II was memorable, and the various admirals were able to return to their respective bases feeling that their duty had been accomplished. As she passed through the Gibraltar Strait on the night of 29/30 September, *Charles Martel* suffered damage to the external supports for the 138.6mm turrets in the heavy swell. Following her arrival at Toulon on 1 October, the battleship was docked at the end of the month, when a W/T antenna and office were installed. This work was followed by a sortie by the 2nd Division off the coasts of Provence and a visit to Ajaccio.

The ships of the squadron were at sea until 10 April 1902 for the traditional port visits then, having transferred part of her crew to the new battleship *Iéna*, *Charles Martel* joined the battleships *Carnot* and *Brennus* in the Reserve Division with a reduced complement. While assigned to this division the battleship visited Golfe-Juan in late August and Les Salins during 3–8 November. From 5 to 20 December she underwent a short refit and made brief sorties to La Ciotat and Sanary; she recommissioned with a full complement on



Bow view of *Charles Martel* at her moorings. Note the pronounced tumblehome of the hull and the massive military mast. The hinged doors over the niche for the bow searchlight projector are open. (DR)



Charles Martel at full speed. She attained 18.13 knots on trials. (DR)

10 June 1903. She then replaced *Gaulois* in the 1st Division, as the latter ship was due to undergo repairs following her collision with *Bouvet*. *Charles Martel* was at Villefranche from 11 to 16 July, and Golfe-Juan until 10 August. The battleship was again assigned to the Reserve Division on 3 October and was in refit from 18 January to 2 February 1904. During this period, the activities of the ship were reduced to a minimum, with short visits to Les Salins and Port Vendres.

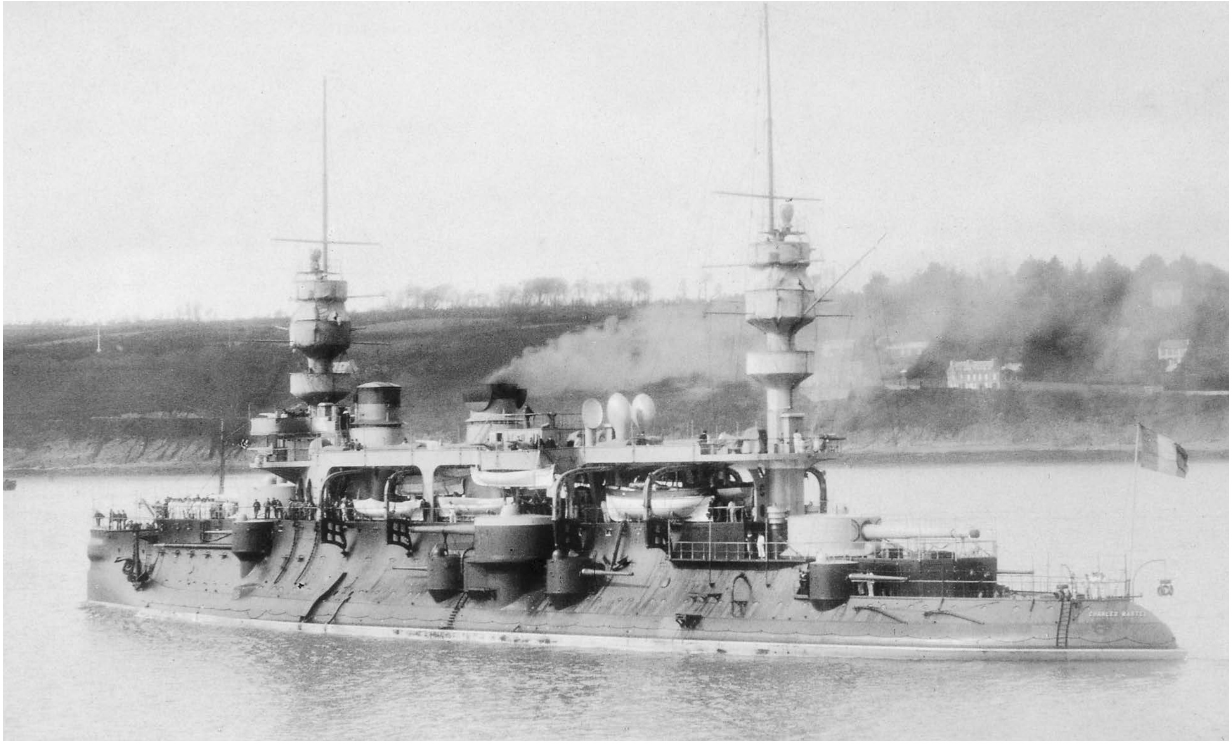
Following the budgetary restrictions imposed by former Minister of Marine Camille Pelletan, which had resulted in the abolition of the combined naval manoeuvres over two years, his successor, Gaston Thomson, reinstated them from 1905. They began on 5 July, when *Charles Martel* sailed for Les Salins to begin the exercises. The Reserve Division was at Bizerte from the 13th, Philippeville on the 18th and Algiers on the 20th. During the gunnery exercises that took place on this occasion, the firing cycle for the 305mm guns was fully nine minutes and that of the 274mm guns more than four minutes!

The end of the year was marked by a short visit to Corsica. In March 1906 there was a port visit to Les Salins. On 13 June, during a maintenance period, the above-water torpedo tubes were disembarked. On 3 July the annual grand manoeuvres began, and the crew were able to visit a number of the North African ports. During the gunnery exercises problems were experienced with the ejection of the 138.6mm cartridges. A total of 496 cartridges were withdrawn from the ship's inventory to be examined, and a request was made for a general inspection of the ammunition on board *Charles Martel*. Following checks, it was found that a particular batch of powder was responsible for over-pressure on combustion, leading to an increase in pressure of 332kg/cm^2 in the chamber, and an increase in muzzle velocity of 17m/s; this served to explain these incidents. It would be the first in a series of problems with *poudre B*, which would result in the loss of two first-line battleships.

From 13 September *Charles Martel* and the fleet participated in a naval review in Endoume roads (Marseille) in the presence of President Armand Fallières, to mark the laying of the first stone of the Rove Canal.

From 8 February to 2 March 1907 the ship was in refit, work being focused on her main guns. Following the loss of *Iéna* to a propellant explosion, *Charles Martel* was employed to conduct firings using the same ammunition that had been embarked in *Iéna*. The next sorties were devoted to the instruction of trainee signalmen. In December a single Barr & Stroud rangefinder was installed, together with a fire control position in the conning tower and two secondary FC positions in the main 305mm turrets. New optical sights were also fitted in the 138.6mm turrets.

1907 had seen the Reserve Division redesignated the 1st Reserve Division of the Fleet, then the Training Division of the Mediterranean, and finally the 4th Division. In 1908 *Charles Martel* had the complement



Charles Martel at Brest on 8 March 1897. (DR)

specified for 'fleet battleships assigned to the training schools'. On 7 November, the ship sailed for Ajaccio with the armoured cruisers *Condé* and *Victor Hugo* to exercise as the force opposing the 2nd and 4th Battle Divisions. On the 20th, during an intense storm, *Condé* grounded on the Aspretto rocks. Having lightened the cruiser as much as possible, *Charles Martel* and *Victor Hugo* managed to pull her off using their combined efforts. The battleship returned to Toulon on the 23rd without further misadventure.

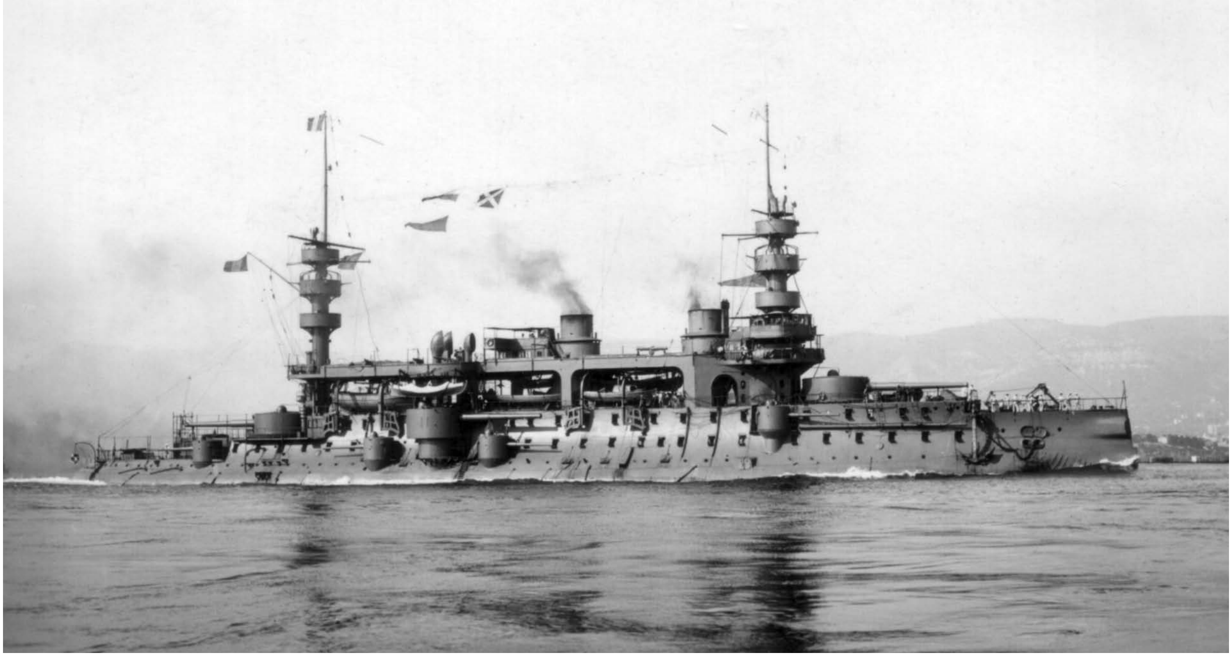
LAST YEARS IN THE NORTH

In late September 1909, *Charles Martel* was selected as the flagship of the Inspector of Flotillas. While performing this role the ship was observing torpedo launches by torpedo boats when a torpedo struck her right propeller, bending the blades. On 5 October she was assigned as the replacement ship for the Northern Squadron. She sailed unescorted to Cherbourg on 5 November, encountering heavy seas that damaged the bases of her 138.6mm turrets, but arrived at her destination eight days later. She was present at the official welcome for the King of Portugal and escorted the British royal yacht *Victoria and Albert*, with King Edward VII on board, back to Britain.

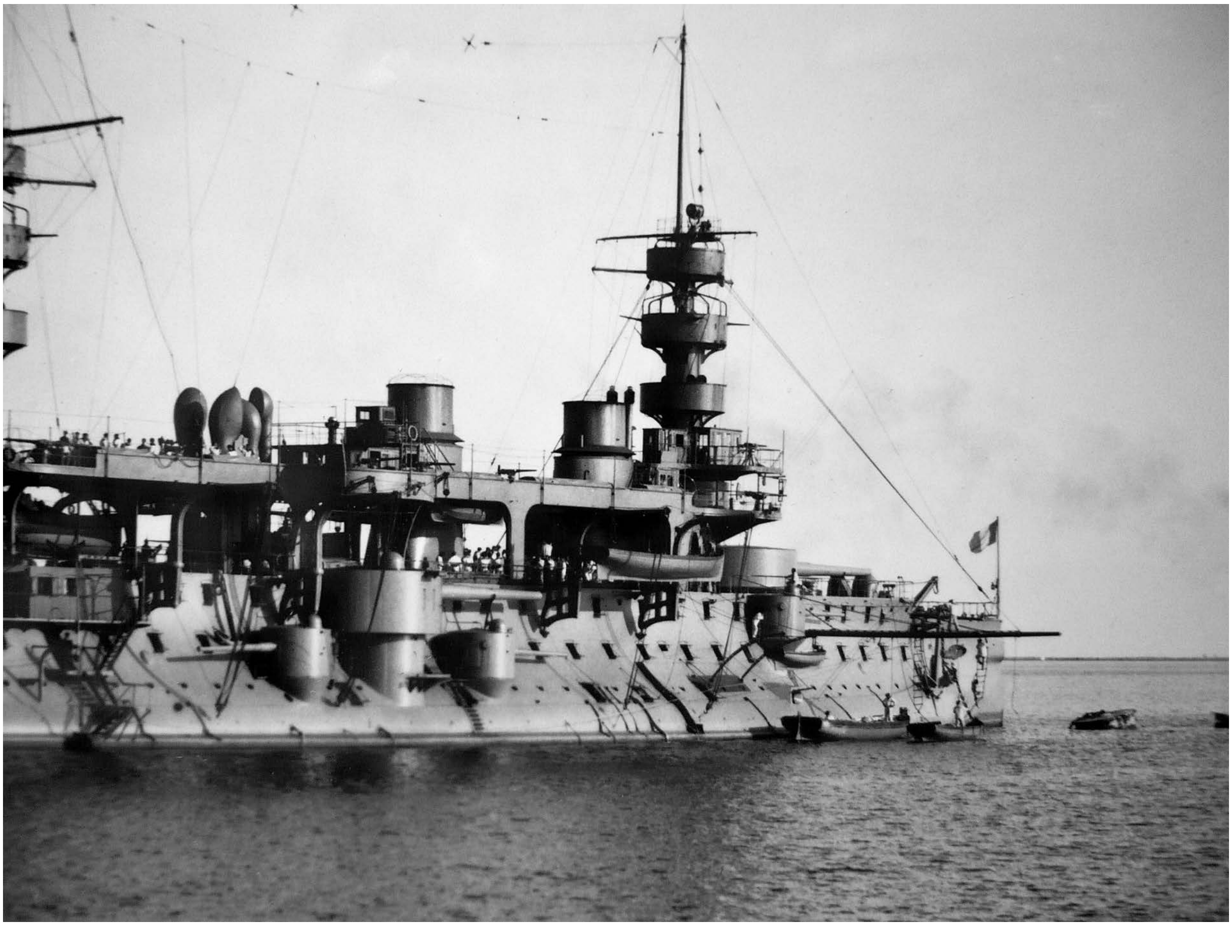
In January 1910, work was undertaken at Brest on the turrets of the secondary guns and on the hull. On 16 October at Cherbourg, *Charles Martel* took the place of *Jauréguiberry* in the 2nd Division. On 5 November of the same year the battleship was struck by lightning, which put her compasses out of action for more than eight months. Following this, *Charles Martel* made only infrequent sorties of short duration, such as the visits to Quiberon in May, June and July 1911. In August Brest dockyard disembarked the hydraulic replenishment apparatus for the main turrets. However, the installation of manual replenishment effectively rendered the main guns useless. On 12 August *Charles Martel* sailed with the 3rd Squadron for Toulon to participate in the great naval review of 4 September, which took place in the presence of President Fallières. On 4 October, following the funeral for the crew of the battleship *Liberté*, lost like *Iéna* to a propellant explosion, she again headed for Brest.

On 1 March 1912 *Charles Martel* was placed in normal reserve then, from 1 July, in special reserve. On 7 April 1913 she transported part of the crew of *Bouvet*, which was under repair, to Brest, then in November was transferred to Landévennec in Brittany. Together with *Brennus, Carnot* and *Masséna*, *Charles Martel* was decommissioned on 1 April 1914.

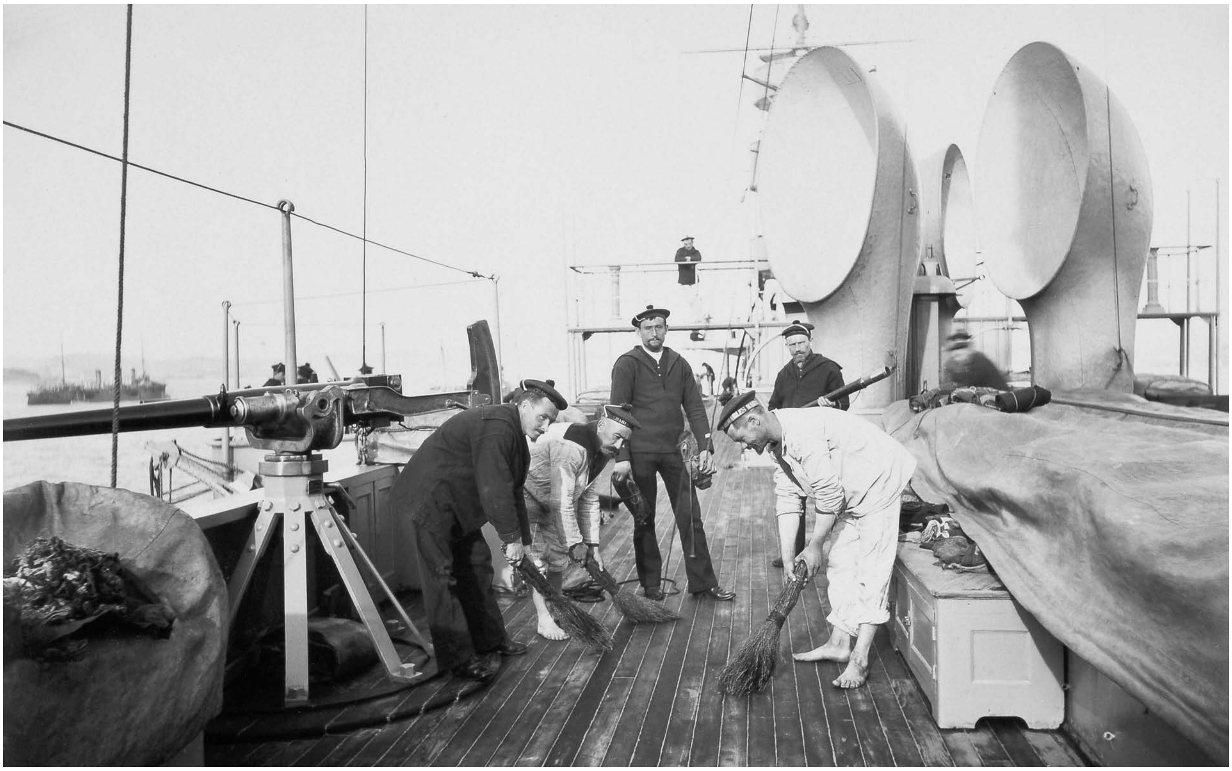
In late September 1914, she served temporarily as a headquarters for German prisoners-of-war who were being held in the various forts along the coast. The PoWs were transferred to Ile Longue in late November. During the conflict, some of her boilers were removed to equip the tugs *Zébu*, *Renne* and *Hippopotame*. In 1915 the two 305mm guns were disembarked and rebored as 370mm howitzers Mle 1915; they were mounted as railway artillery (*artillerie lourde sur voie ferrée* or ALVF). In 1917, the two 274mm were installed on Schneider sliding mountings and likewise employed as railway artillery,



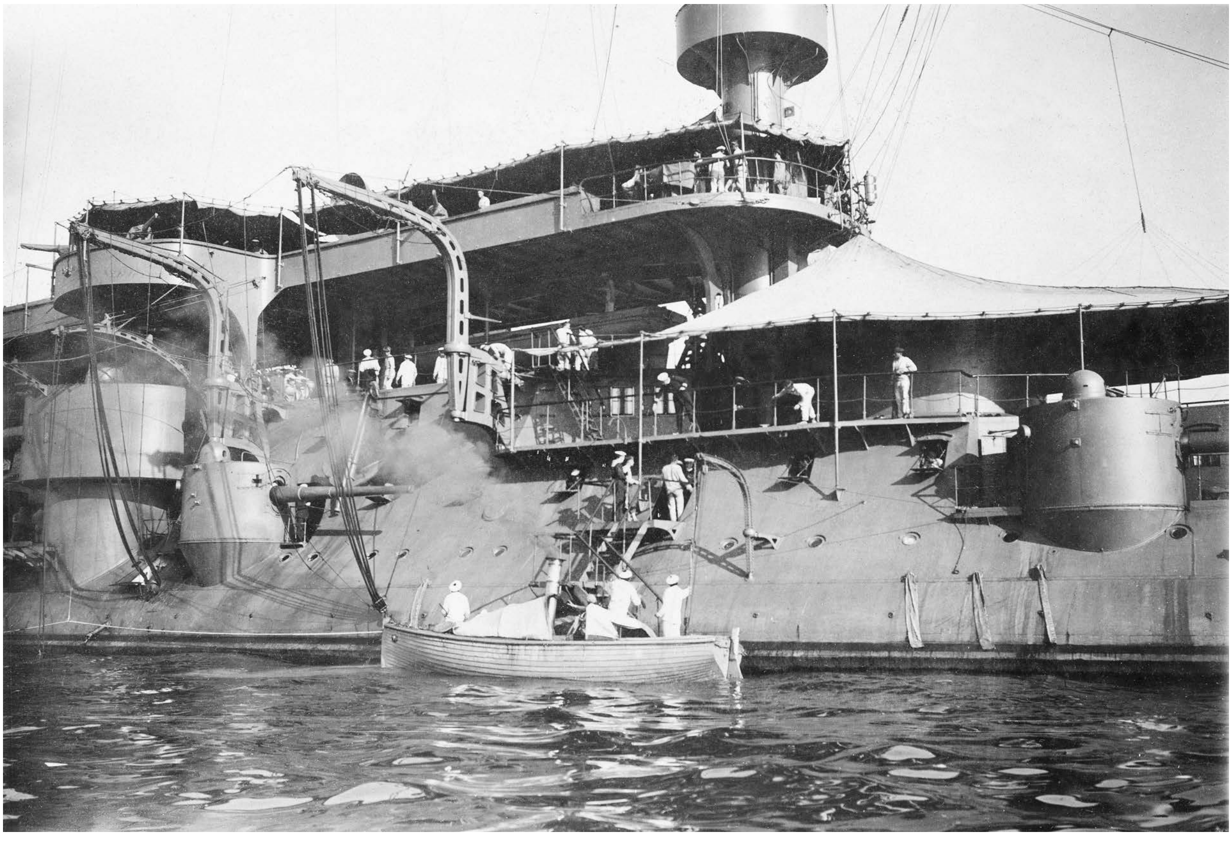
Charles Martel in 1911/1912 in her overall blue-grey livery. The navigation bridge has been re-sited atop the upper platform at the base of the foremast (Marius Bar)



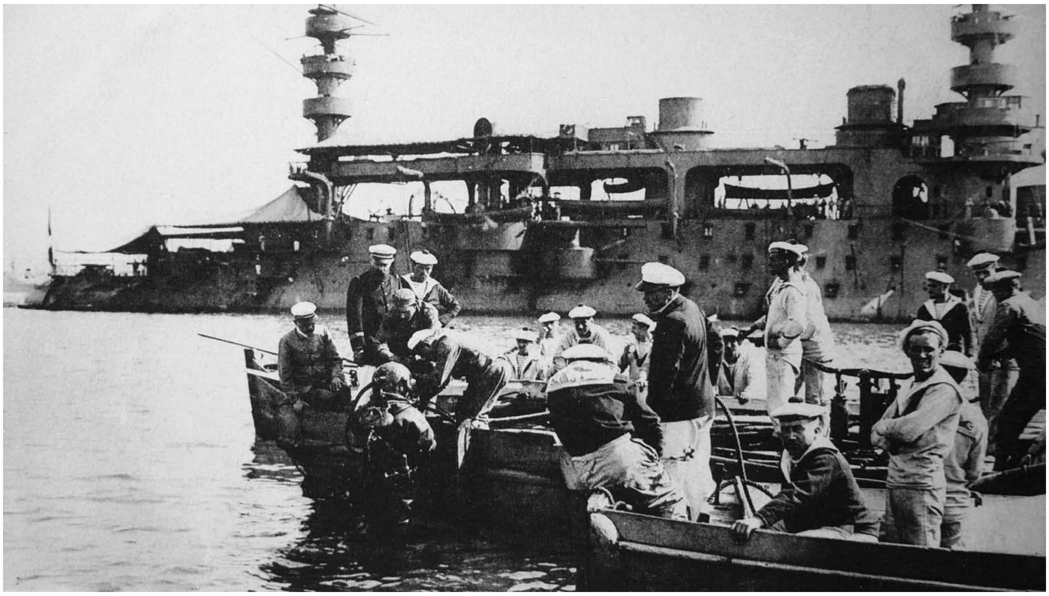
A close-up dating from the same period, with the wing turrets particularly prominent and the 47mm ATB guns on the flying deck above. (DR)



Sweeping the decks: a clearly staged photo, taken on the flying deck of *Charles Martel*, with the prominent ventilation cowls for the engine rooms on the right. On the left is a Hotchkiss 47mm anti-torpedo boat gun. (DR)



The after 138.6mm turrets are prominent in this view, as is the massive flying deck for the light guns. (DR)



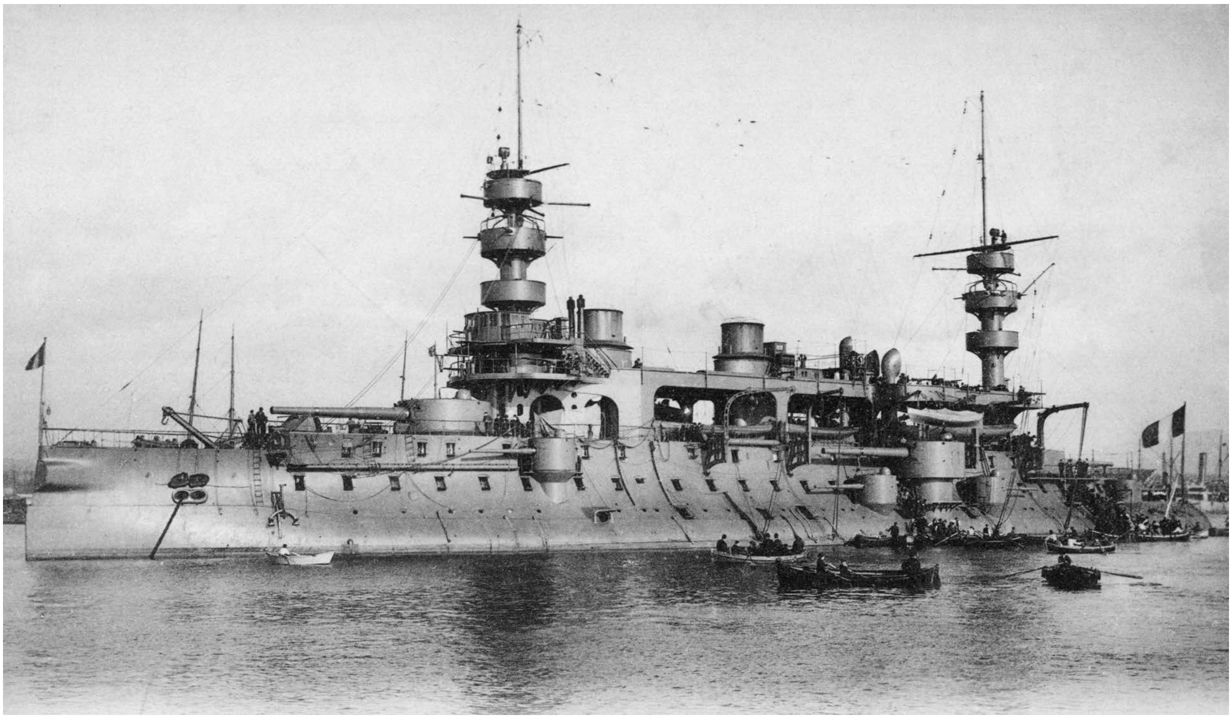
Following the loss of *Liberté* to a catastrophic explosion in September 1911, divers look for bodies. In the background, *Charles Martel*. (Author's collection)

while the 138.6mm guns were given Saint-Chamond wheeled artillery mountings.

Later in the war *Charles Martel* was used as an annex to the 2nd depot, and would again become a floating prison. She was stricken on 30 October 1919 and put up for sale on 21 September 1920. She was sold for 675 000 FF to the Dutch company Franck Rijsdijk Shipbreaking & Co based at Hendrik-Ido Ambacht. The superstructures were removed, and the hull was then towed by the tugs *Humber* and *Hudson* of L Smit & Co International Sleepdienst to be broken up.

Editor's Note:

This article was translated from the French by the Editor. The official plans of *Charles Martel* have not been made available; the profile and plan drawings have been adapted from artwork published in secondary sources, allied to a careful study of photographs.



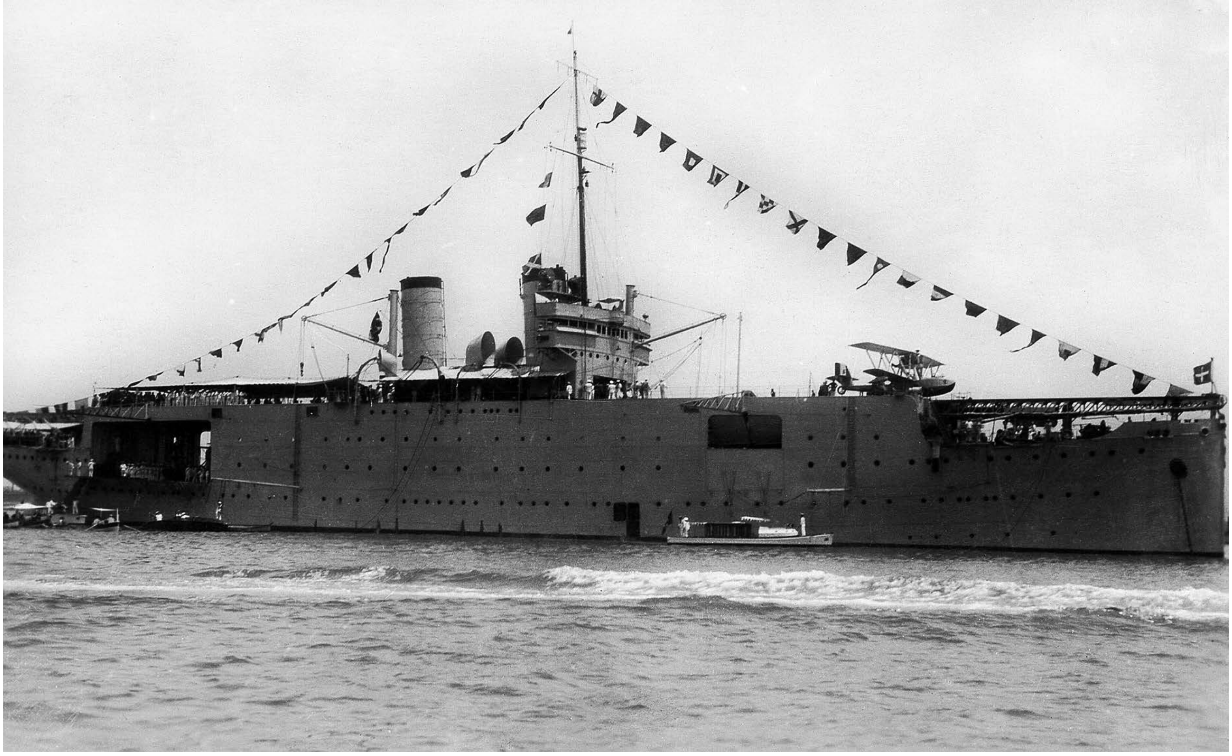
Charles Martel towards the end of her career. (DR)

THE QUEST FOR AN ITALIAN AIRCRAFT CARRIER
1922–1939

In 2007 *Warship* published an article by Enrico Cernuschi and Vincent O'Hara which outlined the political considerations that prevented the Italian Regia Marina from acquiring an aircraft carrier between the wars. In this new, two-part feature **Michele Cosentino** looks in detail at the various air-capable designs proposed during the period.

At the international conference for the limitation of naval armaments held in Washington in 1921–22, the discussions among the five major naval powers (United States, Britain, Japan, Italy and France) on aircraft carriers ended with an agreement which satisfied all national delegations. According to the Washington Treaty, the US and UK were permitted a total standard tonnage of 135,000 tons; Japan was allocated 81,000 tons, while Italy and France were each allotted 60,000 tons. The standard displacement of an individual carrier was limited to 27,000 tons and guns could not be larger than 8in (203mm); as for the number and capabilities of embarked aircraft, no limits were imposed.

With these figures in mind, and amid discussions on operational and technical requirements, some preliminary sketches based mainly on personal initiatives by a handful of naval officers were put forward in Italy during the 1920s. However, the only air-capable ship to materialise was the seaplane tender *Giuseppe Miraglia*. A conversion of a former ferry, she had limited capabilities: her double hangar could house a total of eighteen seaplanes, some of which were broken down, while the

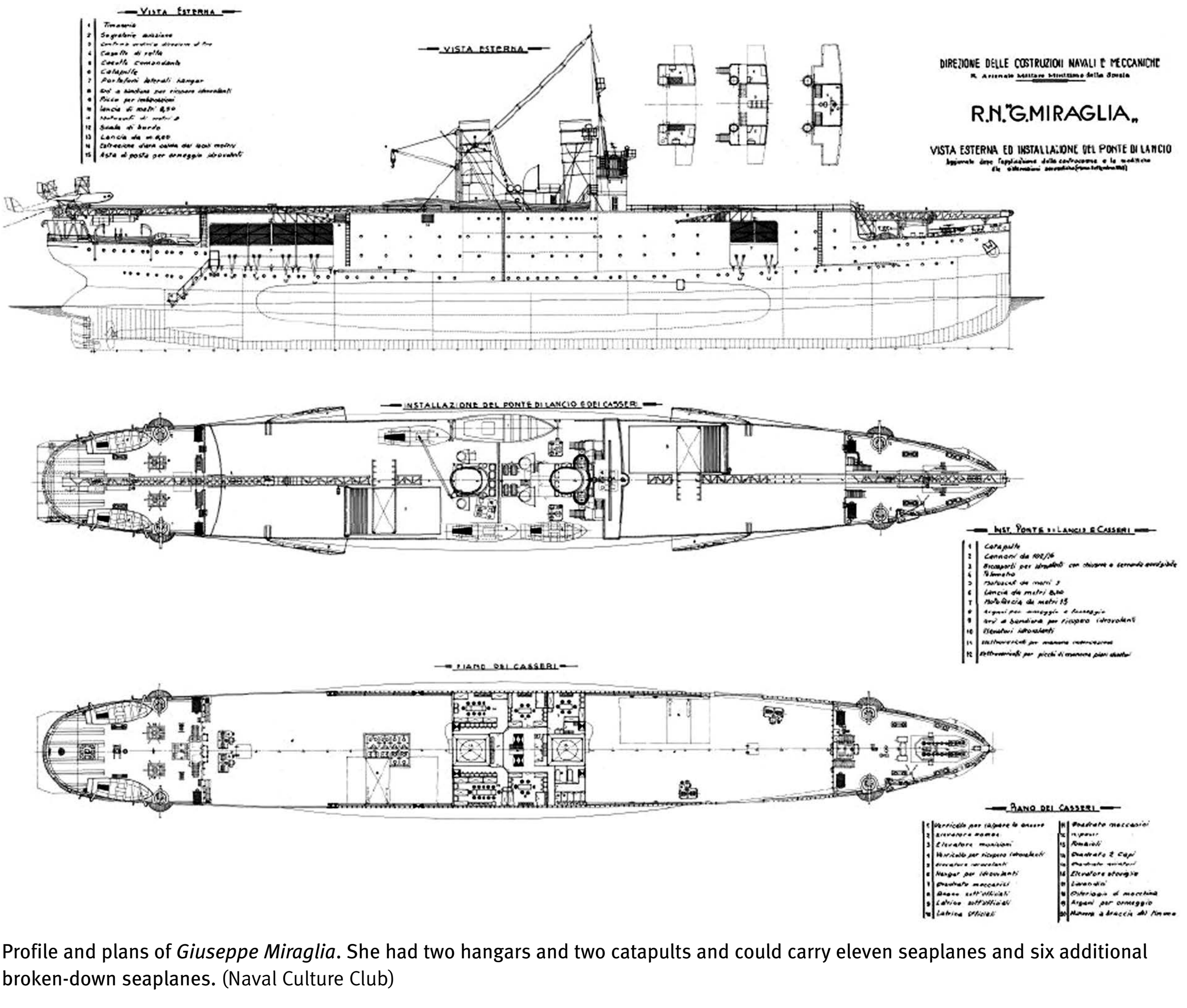


The seaplane tender *Giuseppe Miraglia*, commissioned on 1 November 1927; she was converted from a former ferry. (Italian Navy Historical Office, INHO) modest speed of 18.5 knots allowed *Giuseppe Miraglia* to be operated only as a seaplane tender for aircraft that were to be embarked in Italian battleships and cruisers. *Giuseppe Miraglia* was equipped with two catapults, one of them developed by the then-Major Luigi Gagnotto, Naval Engineering Corps of the *Regia Marina*, one of the few Navy officers who favoured the development of naval aviation and its related technology.

A major step towards the construction of a fully-fledged aircraft carrier was undertaken in 1929, when Lieutenant-General Filippo Bonfiglietti, Naval Engineering Corps, drew up the design for an aircraft carrier displacing 15,240 tonnes standard and equipped with 42 biplanes.[1] However, the very different strategic requirements of the Italian Navy and the Italian Air Force – the latter established in 1923 and officially given ownership of all Italian military aircraft – led to the abandonment of the Bonfiglietti project.

Although the efforts of the *Regia Marina* to design and build an aircraft carrier were thus curtailed, some high-ranking Navy officers continued to debate the need for naval aviation. They were led by Vice Admiral Romeo Bernotti, Deputy Chief of the Italian Navy in the late 1920s and its principal strategist. In his seminal memorandum drafted in 1929 and titled '*La nostra politica marittima*' (Our Maritime Policy), Bernotti focused on the three major arguments employed by those opposing the construction of an aircraft carrier: high construction costs, an increase in the range of shore-based aircraft, and the inability of major surface combatants to host and launch a sufficient number of aircraft for fleet requirements. Of these only the first was recognised as valid, while the others constituted technical and operational risks. In fact, the Italian Air Force had serious doubts about the performance of its coastal seaplanes, while the current aviation facilities on board Italian battleships and cruisers were recognised as inadequate. Highlighting these limitations, Bernotti strongly argued the need for the Italian Navy to own and operate carriers, and reaffirmed the great importance of rapidity and responsiveness in air naval operations.

However, the Italian Air Force had a different agenda and its priorities were far from meeting the *Regia Marina* requirements. The *Aviazione Ausiliaria per la Regia Marina* (Auxiliary aviation for the Navy[2]) had been formally established in 1925 with mostly shore-based


VISTA ESTERNA
VISTA ESTERNA
DIREZIONE DELLE COSTRUZIONI NAVALI E MECCANICHE
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INSTALLAZIONE DEL PONTE DI LANCIO E DEI CASSERI
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PIANO DEI CASSERI
PIANO DEI CASSERI

Profile and plans of *Giuseppe Miraglia*. She had two hangars and two catapults and could carry eleven seaplanes and six additional broken-down seaplanes. (Naval Culture Club)

Vice Admiral Romeo Bernotti, Deputy Chief of the Naval Staff and distinguished Italian naval strategist. (INHO)

Vice Admiral Gino Ducci, who as Chief of the Naval Staff in the early 1930s supported the design of an Italian aircraft carrier. (INHO)

seaplanes owned by the Air Force and manned by mixed crews. This organisation was constantly below its planned size of 35 squadrons: in 1930 it included thirteen shore-based reconnaissance squadrons, two squadrons formed by seaplanes embarked in battleships, cruisers and *Giuseppe Miraglia*, and one shore-based squadron for experimental purposes. Additionally, the aircraft that equipped the shore-based squadrons had inadequate performance, as highlighted in an official report drafted in July 1929 by the then-Deputy Chief of the Air Force, General Francesco De Pinedo, a former Navy pilot during the Great War who later joined the newly-established Air Force. De Pinedo emphasised that the characteristics of both shore-based and embarked aircraft were poor in every sense and stated that they were suitable only for training.

Although this scenario did not favour the establishment of true naval aviation, the debate on the need for an Italian aircraft carrier continued in the specialised press. Recalling the limits established by the Washington Treaty and restated in the 1930 London Treaty, some Navy officers discussed operational and technical requirements and proposed an aircraft carrier displacing 15,000 tons with 60 planes and a maximum speed of 30 knots. Such a carrier should not be equipped with large-calibre guns because they were considered of little value in an operational scenario in which a squadron had always to include an aircraft carrier and thus achieve full fighting efficiency. This remained an innovative concept of the *Regia Marina* in two respects: the presence of several aircraft carriers within a balanced fleet and the insistence – despite the views of many naval experts – on dispensing with anti-ship guns for a type of warship that needed to avoid contact with enemy major combatants. Accordingly, an Italian aircraft carrier had to play two crucial roles: long-range surveillance and reconnaissance, and fleet air defence. Offensive tasks such as torpedo attack or bombing of enemy naval vessels were considered secondary and best left to shore-based aircraft. The justification for such a doctrinal assumption is probably to be found in the hope, within the Italian Navy, of reaching a compromise with the Air Force, which would continue to participate actively in naval air operations.

A new law was passed in 1931 that defined the strength and composition of Auxiliary Aviation for the Navy, but it remained vague about implementation. However, the most relevant and negative consequence for the *Regia Marina* of this new law continued to be the limitation of the tasks assigned to shore-based and embarked aircraft to maritime reconnaissance; ‘combat’ functions such as fleet air defence and strike against enemy vessels were ruled out.

A New Proposal: the Vian Project

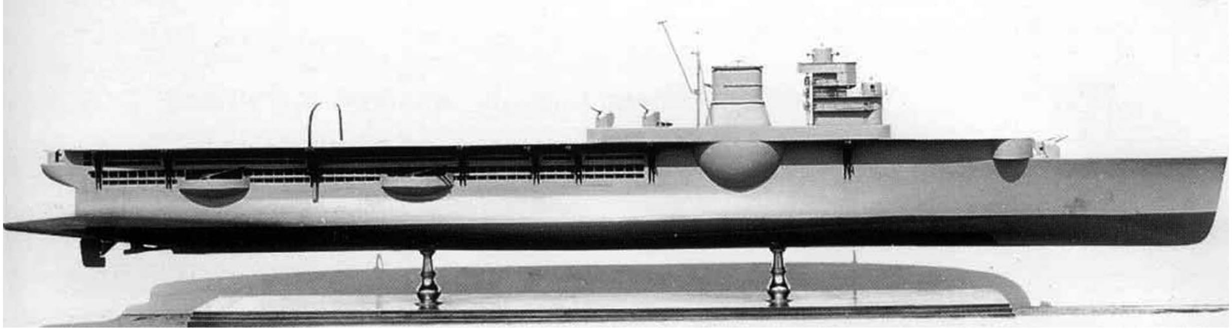
In August 1931 Vice Admiral Gino Ducci became Chief of the Naval Staff. He and his deputy, Vice Admiral Giulio Valli, a former naval aviator, were keen to address and resolve the naval aviation problem and urged the naval attaché in London, Captain Edoardo Sommati, to obtain information on British programmes and the latest thinking. The answers from London focused on the conversion of the 'light battlecruisers' *Glorious* and *Courageous* to aircraft carriers and also highlighted the ongoing studies for a new design aimed at an aircraft carrier displacing 22,000 tons, able to embark 60 aircraft and attain a maximum speed of 30 knots – the future *Ark Royal*. In addition, the naval attaché Sommati stressed the importance accorded by the Royal Navy to aircraft carriers and their roles in a future war, and also made some assumptions about their employment. The information provided by Sommati may have been the prelude to a further and final iteration of the Bonfiglietti project being prepared by the Italian Navy's Warship Design Committee, at that time chaired by General Giuseppe Vian, Naval Engineering Corps. Evidence of this preliminary design lies in a scale model of an aircraft carrier dating back to 1932 and currently exhibited at the Naval Museum of La Spezia. This possible 'Vian project' was for a 15,500-tonne aircraft carrier, but its general configuration appears to be a regression from the Bonfiglietti project. There are no official documents explaining in detail either the Vian project or its genesis, but a close observation of the model provides some interesting details.

The model depicts an aircraft carrier with a flight deck 215 metres long and 30 metres wide which stopped short of the bow and stern – the length of the hull between perpendiculars was 245 metres. Most of the flight deck was supported by pairs of pillars at the sides above a two-level hangar deck. An 80m-long island located on the starboard side included a long deckhouse that supported a large funnel and had five upper levels housing the bridge, two fire control stations and other operational spaces. The flight deck was to be equipped with an aircraft lift placed on the centreline and three arresting wires. However, the most significant feature of the Vian project was in the aftermost section of the ship, which featured a 20m-long slipway, to be used for launching and recovering seaplanes and/or fast torpedo boats. Considering that this project dates back to the early 1930s, the presence of the slipway indicates that the designer was not totally convinced of the performance of wheeled aircraft equipped with arresting hooks, hence the ship's ability to also operate seaplanes.

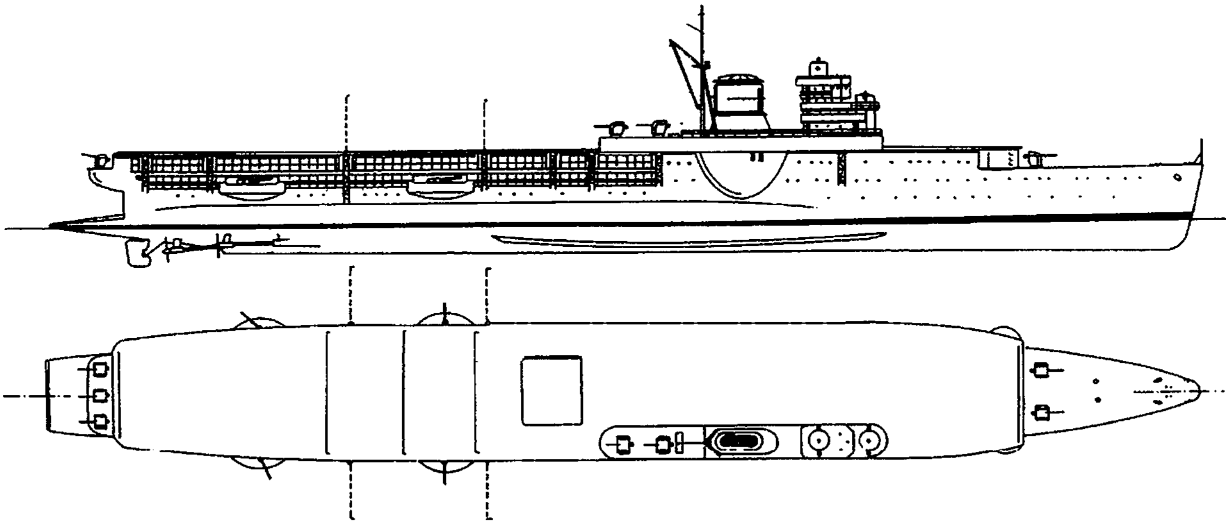
The British aircraft carrier *Glorious*, with her 'stepped' flight deck configuration. She was converted from a 'light battlecruiser'. (Author's collection)

General Giuseppe Vian, Naval Engineering Corps, was the head of the Warship Design Committee of the Italian Navy during the early 1930s. (INHO)

The overall size of the ship would have allowed the embarkation of an air wing similar to that of the Bonfiglietti project, including eighteen fighters, twelve reconnaissance aircraft and ten/twelve bombers. There are no indications as to the types of aircraft, monoplane or biplane, wheeled or with floats. The openings in the hull sides below the flight deck indicate a hangar deck 120 metres in length, and it is safe to assume two features for the Vian project: a gallery deck immediately below the flight deck and an underwater protection system based on the cylinders patented by the then-Colonel Umberto Pugliese, Naval Engineering Corps. There are no details regarding machinery, but the presence of four shafts suggest provision for four to six boilers that



A model of the aircraft carrier designed by General Giuseppe Vian, currently exhibited at the Naval Technical Museum in La Spezia. (INHO)



Profile and plan of the Vian project, with a shortened flight deck fore and aft and a slipway at the stern to be used for launching and recovering seaplanes. (Erminio Bagnasco)

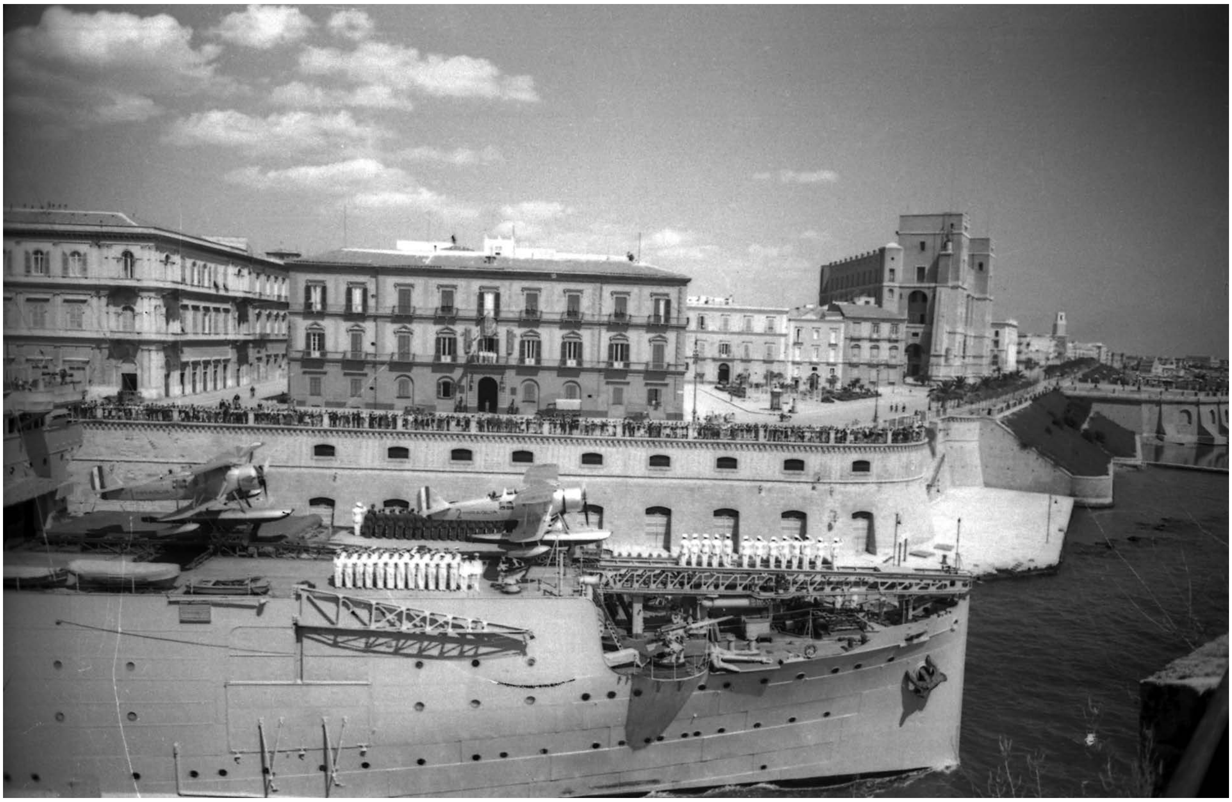
supplied steam to four sets of geared turbines; power would total no less than 80,000shp for a maximum speed of 28–29 knots. There was a semi-balanced rudder and two bilge keels.

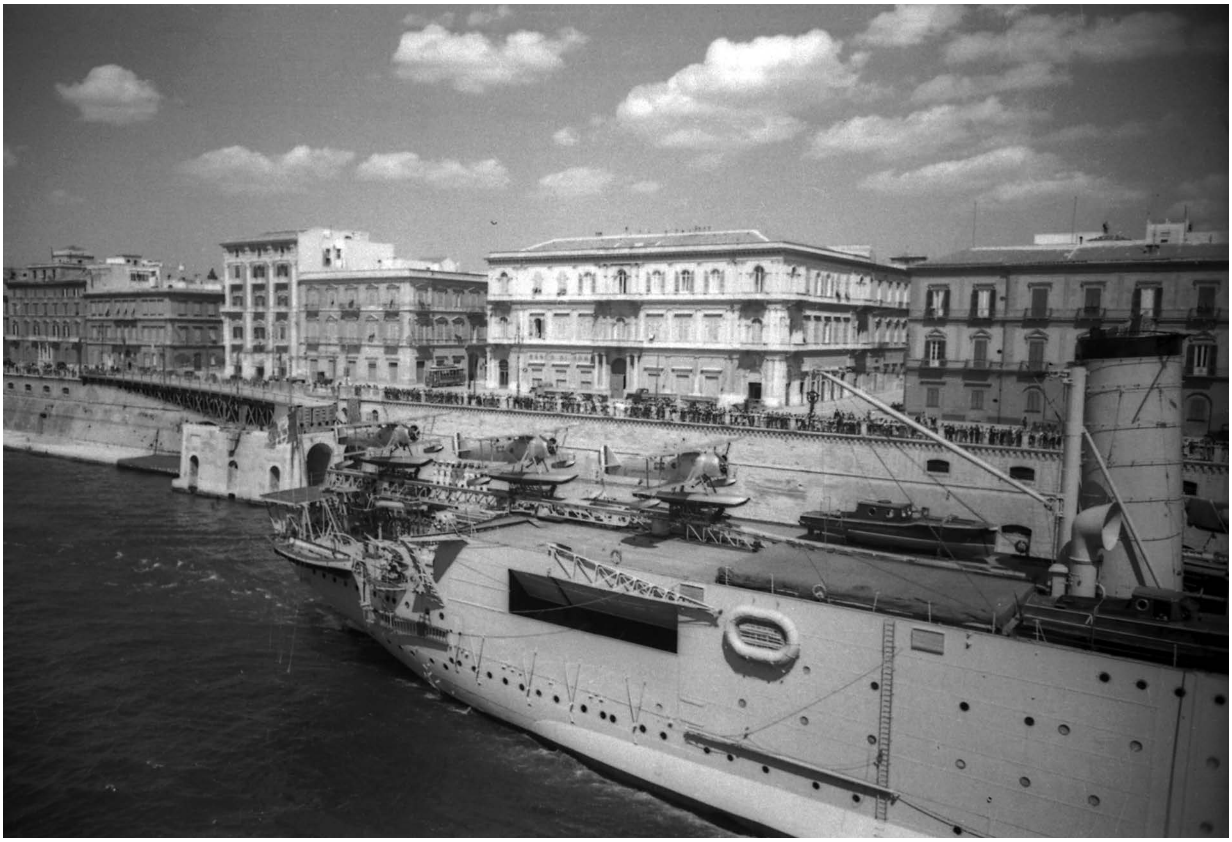
The composition of the armament distinguishes the ship from earlier designs and sketches of Italian aircraft carriers, which featured large twin turrets located at either end of the island. The projected Vian carrier was armed with four Ansaldo Model 1929 152mm guns – a development of the earlier Ansaldo Model 1926 – for anti-surface engagements. The guns were in single mountings on side sponsons at the level of the hangar deck on either side of the after section of the hull. Anti-aircraft defence was provided by seven OTO Melara 100mm Model 1931 guns in single shielded mountings; these were located at the after end of the island (two mounts), and forward and aft of the flight deck (two and three mounts respectively). However, the Vian project remained a theoretical exercise because it received neither political support nor practical implementation. Additionally, it did not represent an evolutionary approach to be exploited later, still within the limits that the Washington and London treaties allotted to Italy.

Original Ideas and Forced Compromises

For the *Regia Marina*, the early 1930s was a period of assessment and expectation in terms of naval and procurement policy, but naval aviation still relied exclusively on seaplanes and floatplanes embarked in cruisers. Two *Trento*-class heavy cruisers, completed during the late 1920s, were joined by four *Zara*-class vessels: each of them had a catapult set into the forecastle and a small hangar housing two floatplanes.[3] Four light cruisers of the '*Condottieri*' type were also commissioned, each of them likewise equipped with two floatplanes. A seventh heavy cruiser, *Bolzano*, and two additional light cruisers were commissioned in 1933, adding a further six floatplanes to the embarked force of naval aircraft. There were also plans to embark four floatplanes in each of the two *Cavour* class battleships, dating back to the First World War and due to be modernised in the La Spezia Naval shipyard, but this proposal was abandoned for technical reasons.

An Italian naval squadron in the mid-1930s would typically comprise between three and four cruisers plus *Giuseppe Miraglia*, and could deploy fifteen embarked aircraft for surveillance, reconnaissance, fire control and

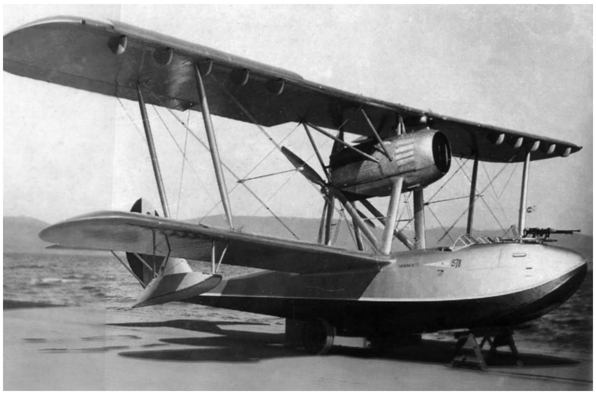




Two views of *Giuseppe Miraglia*, taken while the ship was exiting the Mar Piccolo at Taranto. The fore and after catapults and other aeronautical equipment are clearly visible. (INHO) limited fleet air defence. However, this scheme was difficult to implement due to three weaknesses: the poor performance of embarked seaplanes, the cumbersome process needed for their employment, and the slow speed of *Miraglia*. Partial improvements in the effectiveness of such a hypothetical naval squadron might come about by excluding *Miraglia* and procuring better types of embarked seaplane, but the priorities for the Italian Air Force were very different. Deploying and operating one or more aircraft carriers would have been the ideal and effective solution to the Italian naval air problem, but this was precluded by the political climate.

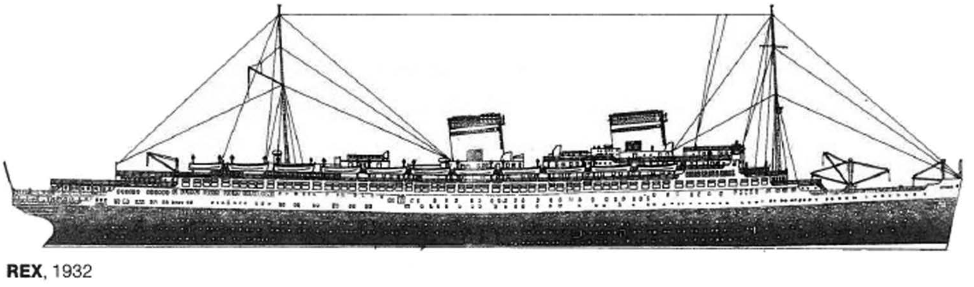
A new potential solution to the problem emerged in 1933, when Vice Admiral Ducci considered the conversion of *Rex,* a fast transatlantic liner that had won the famous Blue Riband after crossing the Atlantic at an average speed of 28.92 knots. The proposal also included the conversion of another large transatlantic liner then being built, *Conte di Savoia*, and was essentially based on the high speed of these steam-powered liners. Thanks also to their size, internal volume, and characteristics (a length of 240–250 metres, a maximum beam of 30 metres, a tonnage of 48,500grt, a maximum speed of 27 knots and a cruising speed of 20 knots), these two fast steamers represented a good starting point to obtaining, through a suitable conversion, an aircraft carrier both able to operate a sizeable air complement and to deploy as an integral part of a naval squadron comprising the Italian cruisers then in service or planned.

A feasibility study identified *Conte di Savoia* as the most suitable vessel to be modified as an aircraft carrier. However, a radical conversion was ruled out due to technical issues, and the proposal focused on the adaptation of the ship by arranging a suitable number of seaplanes and their equipment on the upper decks, thus avoiding the total reconstruction of the superstructures. The staff requirements called for an undefined number of seaplanes stowed on three upper decks and supported by a large workshop area, and a preliminary study was assigned to Lieutenant-Colonel Giuseppe Malagoli, Naval Engineering Corps, who in 1933 had won a prize competition related to the conversion of *Conte di Savoia*. Introducing his study, Malagoli reaffirmed the advantages of an aircraft carrier being part of a naval squadron tasked with attacking enemy commerce. He therefore proposed a carrier equipped not only with reconnaissance/fighter planes but also with bombers, justifying his choice with the results of the exercises then being conducted by the US Navy with its already established ‘carrier striking groups’.[4]

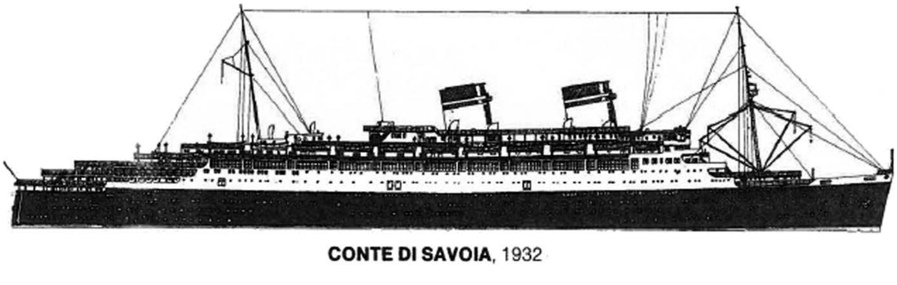


The Savoia Marchetti SM.78 was the bomber seaplane taken which would have operated from the converted fast liners, and which influenced their redesign. (Italian Air Force)

However, the key issue for Malagoli in his technical-operational assessment was his lack of confidence in the architectural solution of a traditional aircraft carrier equipped with a flight deck, because he judged that the landing manoeuvres were too dangerous for aircraft returning from a long-range mission, especially in adverse weather conditions. Malagoli proposed a solution based upon the performance of the Hein Mat device and, consequently, a conversion of *Conte di Savoia* which focused on the use of seaplanes, to be launched by cata-

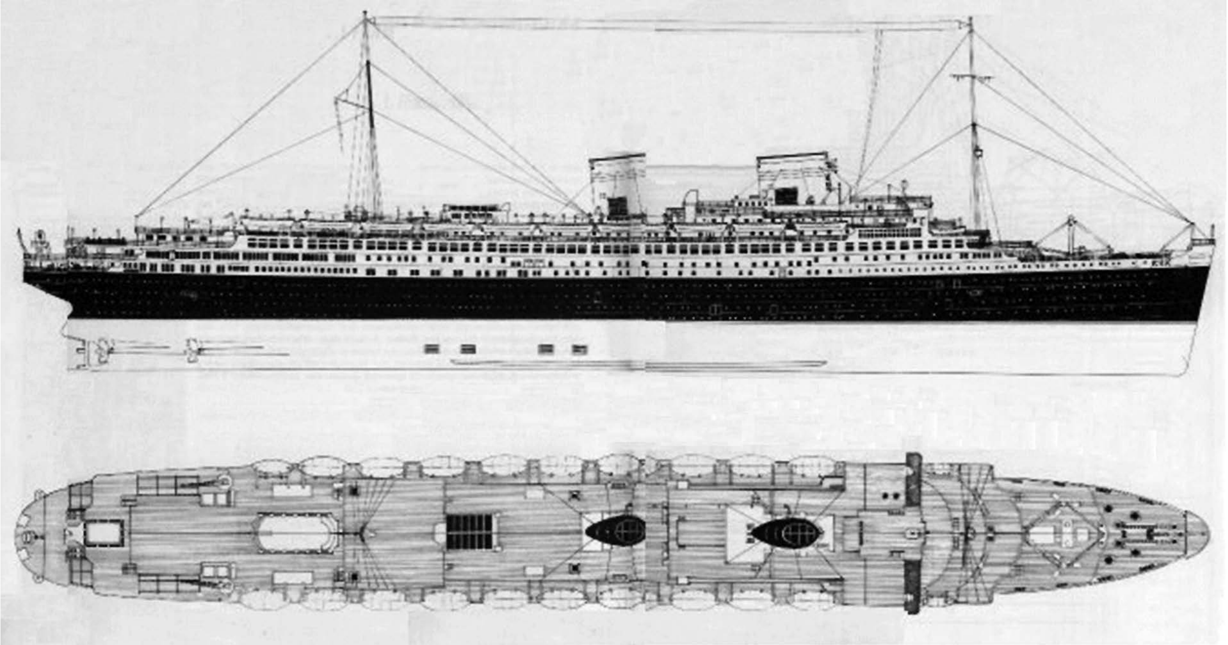


REX, 1932



CONTE DI SAVOIA, 1932

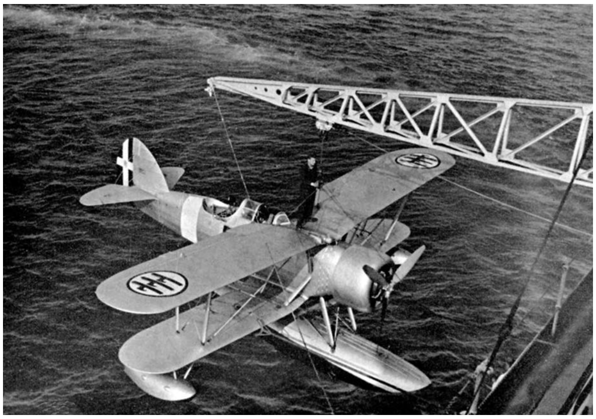
Profiles of the fast transatlantic liners *Rex* and *Conte di Savoia*; they were considered for conversion to aircraft carriers. (Società Italiana di Navigazione)



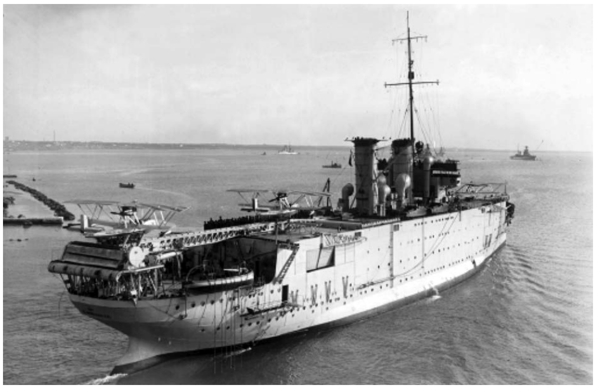
Profile and plan views of *Rex*. A possible conversion would start with the dismantling of the upper decks. A pair of two-level hangars would then be installed fore and aft. (Società Italiana di Navigazione)

pult and recovered using the 'mat', which was deployed in the ship's wake. For the bombing role, Malagoli identified the Savoia Marchetti SM.78, a two-seater biplane with a 12.26-metre fuselage, armed with six 200lb bombs and four 7.7mm machine guns. The reconnaissance/fighter aircraft would have been the Ro.43 manufactured by the company IMAM and already embarked in Italian cruisers.

The conversion of *Conte di Savoia* would include the elimination of the mainmast, the resizing and repositioning of the foremast, the partial demolition of the upper decks forward and aft of the funnels and the installation of structural reinforcements needed to construct a pair of two-level hangars. The after hangar was to be sized to house thirteen SM.78 bombers, to be launched by a pair of 20-tonne trainable pneumatic catapults located on the roof of the upper hangar; a hydraulically-operated lift was to connect the lower and the upper hangar. The other two-level hangar was to be placed forward of the first funnel and would house twelve fighter/reconnaissance planes to be launched using two fixed 11-tonne catapults. A Hein Mat and its deployment gear were to be fitted astern of the after hangar, below the weather deck; when a seaplane bomber landed, a derrick would raise it from the Hein Mat and transfer it onto the aircraft lift in the upper deck. The seaplane would then be moved one level below and made ready for another launch.



An IMAM Ro.43 floatplane being hoisted aboard *Giuseppe Miraglia*. This model of floatplane was embarked in the Italian major naval combatants of the period and was chosen as a fighter for a potential Italian aircraft carrier designed in the mid-1930s. (INHO)

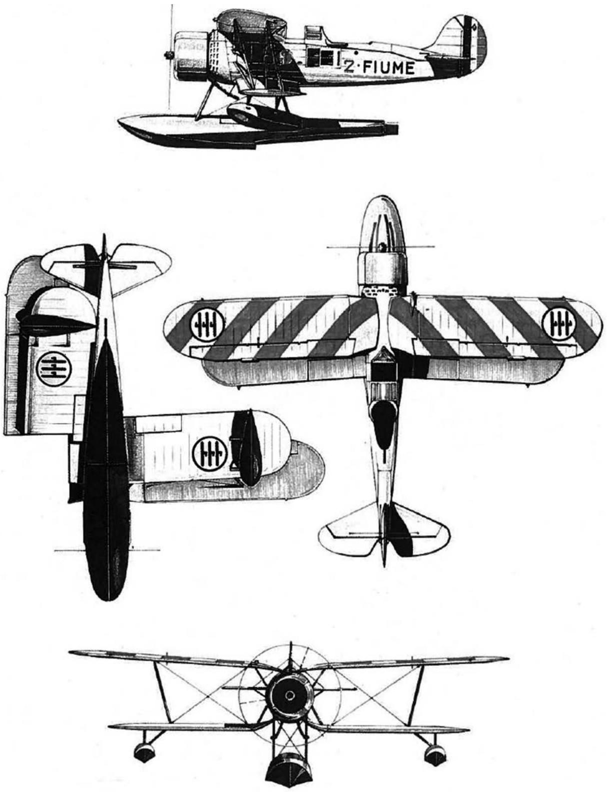


Giuseppe Miraglia leaves the naval base at Taranto in 1935. The Hein Mat device is clearly visible above the stern, while the two seaplanes on the after catapult are Macchi M 18 AR, with folding wings. (INHO)

The smaller fighter/reconnaissance floatplanes were to be recovered by a derrick located close to the forward hangar. Malagoli stated that such a disposition could be rearranged in order to simplify and speed up the recovery process and avoid the installation of too many catapults. Spaces for maintenance and support of the embarked seaplanes were to be placed close to the hangars: aviation fuel tanks and magazines for bombs and ammunition would be located below the weather deck. Passenger cabins would be rearranged to provide suitable spaces for officers and men.

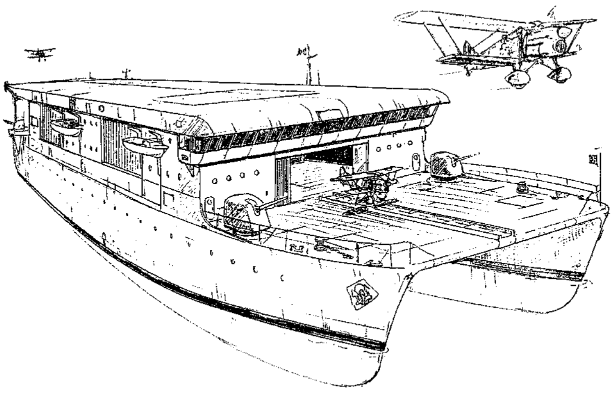
In his concept of operations for *Conte di Savoia,* Malagoli predicted that fleet air defence would require a great number of fighter floatplanes ready for launch, with wings deployed. To maximise the utilisation of all available deck surfaces, the preliminary study also included two small hangars located between the two funnels that were to house four additional Ro.43s with folded wings. This solution would increase to twenty-nine the total of embarked seaplanes. Although such an aircraft carrier could rely upon its own embarked planes for defence against enemy warships, Malagoli envisaged two twin 120mm mounts, one located forward between the fixed catapults and the other positioned close to the area devoted to engine testing. Unfortunately no drawings or plans of Malagoli's preliminary study have survived. We do know that it did not satisfy Admiral Ducci because its author had conceived an attack carrier, a concept which did not meet the strategic requirements of the Italian Navy for an air-capable ship. Also, the recovery evolutions for the seaplanes remained complex and cumbersome, probably forcing them to land nearby at the closest coastal land base after having carried out their mission and thus limiting the overall operational value of the ship.

The transformation of a fast ocean liner into an aircraft carrier was a solution which failed to convince the Italian Naval Staff. In March 1934 they toyed with another concept based on using fast merchant vessels converted for naval air operations with an antisubmarine focus, the aim being to protect the sea lines of communication radiating from Italian ports. This decision stemmed from a recognition that coastal-based aviation was not capable of providing antisubmarine reconnaissance and defence in open waters. In practice, this meant an air-capable vessel specifically designed for convoy escort. Malagoli initiated a preliminary study to convert at least four steamers, each of them capable of carrying four to six fighter/reconnaissance floatplanes. The vessels considered for conversion were the diesel-powered freighters of the *Egeo* class, which had a tonnage of 3,220grt and a maximum speed of 14 knots. These features and their internal arrangements made them suitable for conversion as seaplane carriers, each embarking five Cant 25 A.R.



A four-view graphic of the IMAM Ro.43 floatplane embarked in the Italian cruiser *Fiume*. An Italian naval squadron comprising three to four cruisers and *Giuseppe Miraglia* could potentially deploy fifteen seaplanes. (INHO)

General Umberto Pugliese, Naval Engineering Corps. In his project for an aircraft carrier drawn up in 1936,Pugliese tried to convince the Italian Naval Staff that a maximum speed of 38 knots was an exaggerated requirement. (INHO)



In the mid-1920s, Air Force General Alessandro Guidoni, a former naval pilot and engineer, proposed a catamaran-hulled aircraft carrier with a 'stepped' flight deck configuration. This unconventional proposal featured a 100m-long hull, a hangar capable of accommodating 25 wheeled aircraft, and a maximum speed of 32 knots. (Franco Harrauer)

aircraft with folding wings, to be launched with a Gagnotto-type catapult and recovered by the Hein Mat device. Armament would include two 120mm and two 76mm HA guns in single mountings. However, by the end of 1934 the Italian Naval staff decided not to pursue these conversions and adaptations, and ordered a halt to any implementation of the studies, which were put in abeyance for potential future needs.

Naval Policy and Aircraft Carriers: a New Opportunity

In September 1935 increased tensions between Italy and Britain convinced the Italian Naval Staff to accelerate design initiatives aimed at building an aircraft carrier. The initial requirements called for a displacement of 14,000 tonnes and 38 knots as maximum speed – an exaggerated figure. It was decided to embark only two types of aircraft: fighters and torpedo/bomber/reconnaissance (TBR) planes. At the time, the Navy's Warship Design Committee was led by General Umberto Pugliese, who initially envisaged a ship equipped with catapults and arresting wires, a starboard island and a 130m-long after section of the flight deck, this being assumed as a minimum for aircraft landing. Nevertheless, as yet there was no open discussion regarding aircraft carriers within the Italian Naval Staff, led since June 1934 by Vice Admiral Domenico Cavagnari. The Pugliese study was therefore put on hold, but some hull testing with scale models was carried out at La Spezia. The results of these tests allowed Pugliese again to put forward his studies in March 1936, this time with Cavagnari's approval. In the Italian Navy Historical Office there are some papers describing these studies, but unfortunately there are neither plans nor graphical illustrations of what has been dubbed the 'Pugliese project'. It was disclosed in a meeting of the Admirals' Committee[5] in July 1936 and constitutes an important document to inform our understanding of the current state of Italian aircraft carrier design.

Describing aircraft carriers then in commission or being built abroad,[6] Pugliese requested authorisation to finalise his project, and explained some of the design elements that had already been defined. As for maximum speed, Pugliese stated that almost all modern foreign aircraft carriers were capable of 31 to 33 knots, and tried to convince his colleagues that 38 knots was an unrealistic figure for a ship displacing 14,000 tonnes. Even if a suitable hull form could be combined with a power plant of 160,000shp, the maximum achievable speed would be 36 knots, but this figure remained excessively high. The power plant would comprise eight boilers and four sets of geared turbines arranged to allow sufficient space for installing the Pugliese-designed underwater protection system. As far as protection was concerned, Pugliese was aware that the limits imposed on displacement did not provide much of a margin, and proposed a 60mm vertical belt at the waterline to protect the vital spaces. There was not even sufficient weight available for horizontal protection, and the ship would rely for her defence only upon her fighters and antiaircraft weapons. When the Pugliese project was drafted there was no certainty about the type of embarked planes and their ancillary equipment. However, Pugliese envisaged an air complement of 42 planes, all housed in the hangar and comprising 24 fighters and 18 TBR aircraft. As for the armament, in principle the aircraft carrier should avoid

Vice Admiral Domenico Cavagnari was the Chief of the Italian Naval Staff from 1934 to 1941. Cavagnari was not a supporter of naval aviation. (INHO) engagement with battleships and cruisers. Two 152mm triple turrets would be sufficient to cope with enemy destroyers, and the turrets would be positioned at either end of the island with a fire control system atop a tower mast. Antiaircraft defence would be provided by ten 90mm single mounts, arranged at either end of the flight deck and one level below.

In his report, Pugliese talks of a 196-long flight deck that would extend for the entire length of the hull. The latter would also comprise a two-level hangar on the main deck, 1st and 2nd platform decks and hold. Taking into account these parameters and the results of some tank tests carried out in La Spezia, Pugliese listed the main characteristics of his aircraft carrier (see accompanying table).

In his report Pugliese stressed again the need to reduce the designed speed, and also explained the advantages of using a suitable number of diesel engines, a model of which was currently being developed jointly by the *Regia Marina* and an Italian private company. Finally, Pugliese again suggested the conversion of some steam-powered liners into aircraft carriers, a proposal in line with the previous expressed intentions of the Italian Naval Staff and this time based on the conversion of the 26-knot steamer *Roma*. Another proposal for the conversion of the 19-knot diesel-driven passenger vessel *Augustus* attracted little attention. The Pugliese project was discussed in a second meeting of the Admirals' Committee held in August 1936. Some members stated the need to increase the offensive and defensive capabilities of the future Italian aircraft carrier, but nobody seemed to contest the exaggerated speed requirement. However, Pugliese insisted on a final definition of operational requirements for any future aircraft carrier, namely speed, protection, number of embarked planes and displacement, thus allowing the Warship Design Committee to proceed with a more concrete design. The exchange of letters between Pugliese and Cavagnari about the future design of Italian aircraft carriers ended without any positive outcome because the Italian Naval Staff was not able to reach a unanimous position on such an important issue.

Pugliese Carrier Proposal

Length	211m oa; 206.9m wl
Beam	25m wl
Displacement (trials)	15,000 tonnes
Draught	4.5m*
Flight deck	196m x 30m
Aircraft in hangar	24 fighters, 18 TBR
Catapults	One for fighters, two(?) for TBR
Armament	Six 152mm (2 x III), ten 90mm (10 x I)
Propulsion	Eight boilers, 4-shaft geared turbines; 160,000shp for 36 knots
Endurance	4,000nm at 25 knots

* This comparatively low figure comes from Pugliese's notes and was based on a displacement of 13,000 tonnes; Pugliese wanted to keep draught as shallow as possible to minimise the effects of a underwater explosion.

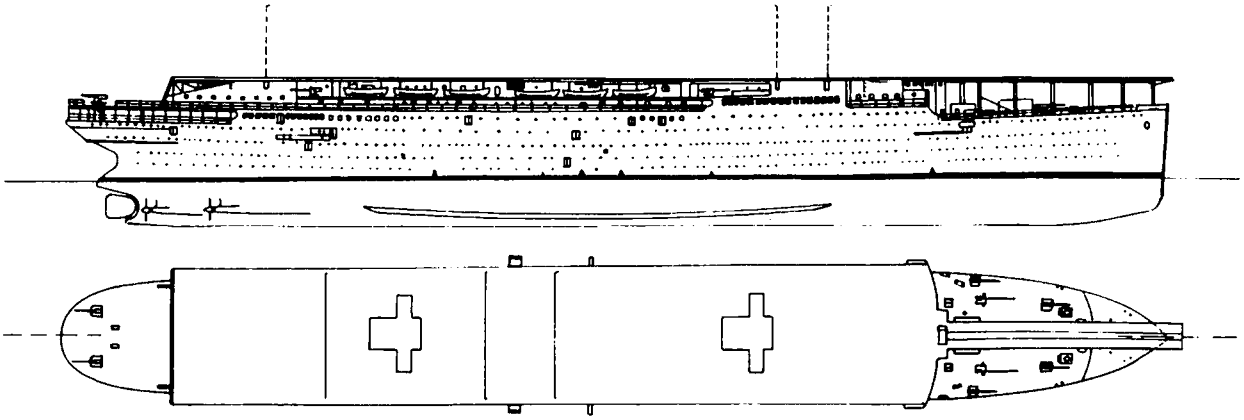
The Planned Conversions

At this time, another crisis erupted in the Mediterranean because of the Spanish Civil War. The Italian Naval Staff was concerned about a potential confrontation with the Royal Navy and the *Marine Nationale* and again discussed potential means of providing an effective fleet air defence. In order to deliver on this urgent requirement, the Warship Design Committee worked on two projects for converting the steamer *Roma* as an aircraft carrier.[7] Both initiatives were to be considered very preliminary projects but they included some interesting features.

Roma had been commissioned in 1926, had a tonnage of 30,816grt and could accommodate 1,000 passengers; length was 231.4 metres. The machinery featured four shafts and included boilers and geared turbines that had originally been earmarked for installation on the never-built battleship *Cristoforo Colombo*. The propulsion plant was therefore technologically obsolete and was able to develop only 36,000shp, which corresponded to a maximum speed of 20 knots. Since this speed was rightly considered inadequate for an aircraft carrier that was to operate within a naval squadron that included faster battleships and cruisers, the Italian Naval Staff decided to adopt more modern machinery.

The first preliminary study for the conversion of *Roma* was probably developed in the early summer of 1936. It envisaged the dismantling of all superstructures, cabins and lounges above the weather deck and the construction of a box-shaped structure 145 metres by 27.4 metres to support a hangar and flight deck. The latter had a length of 195 metres but its forward section was only 5 metres wide to accommodate a Gagnotto-type pneumatic catapult. The flight deck was connected to the hangar by two aircraft lifts located on the centreline; there was no island, but the forward section of the box structure included a navigation bridge. Stability and underwater protection were to be assured by bilge keels and a pair of deep bulges placed along the central section of the hull. The latter would increase the waterline beam and reduce speed, but this would be compensated by the installation of more powerful machinery that could deliver a maximum speed of no less than 28 knots. Although there is no definite information on the composition and size of the embarked air wing, it would probably have comprised 30 aircraft with non-foldable wings, an assumption based upon the ship size, the configuration of the lifts, and a comparison of this preliminary design with the projects for Italian aircraft carriers already discussed. Six 100mm in single mounts were to be placed on the weather decks at either end of the flight deck: four forward and two aft. A further four mounts were located on sponsons to the sides of the hangar.

The second initiative to transform *Roma* into an aircraft carrier went beyond the preliminary stage. In



The first tentative proposal to convert the passenger steamer *Roma* into an aircraft carrier was drawn up in the summer of 1936. It featured a 145m-long flight deck with a fixed pneumatic catapult at its forward end. (Erminio Bagnasco)

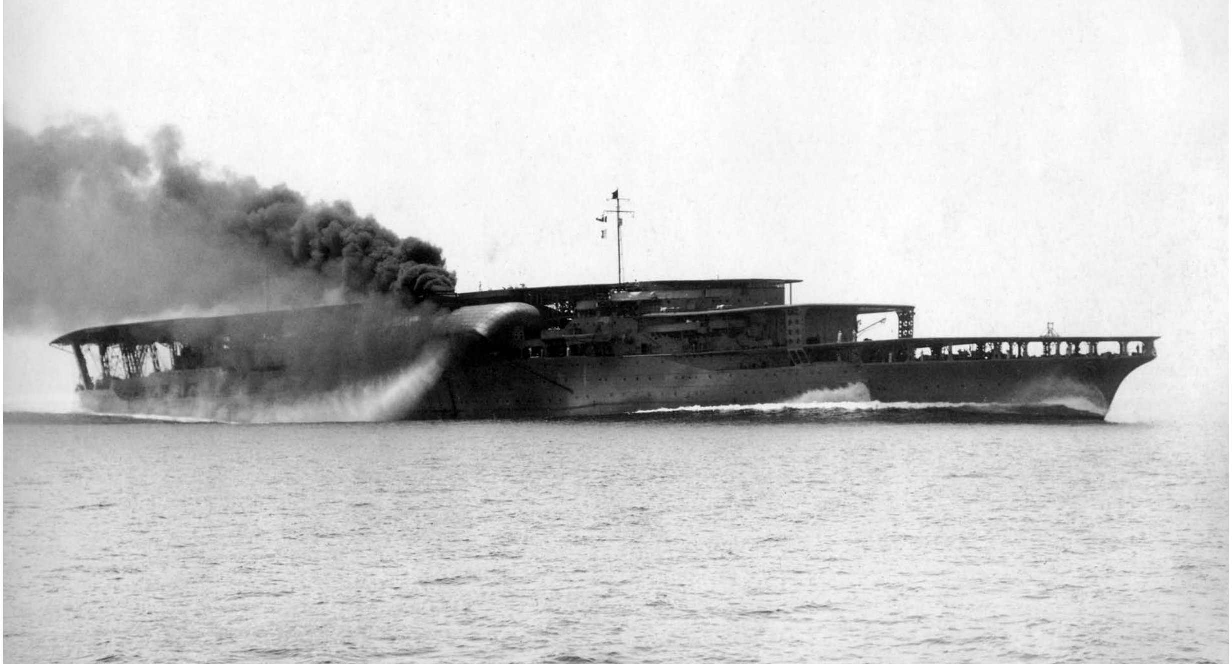
August 1936 then-Colonel Luigi Gagnotto was detached to the Ansaldo shipyards in Genoa and developed a preliminary design for an aircraft carrier named 'Pg. n.796/Ansaldo' that was later dubbed as the *Roma*/Gagnotto project. Some sketches and a summary report of this work provide several interesting information about the concepts and ideas developed by Gagnotto. Broad guidelines endorsed by the Warship Design Committee included a flight deck capable of launching and recovering many types of embarked aircraft, a hangar capable of stowing as many bombers and fighters as possible, the replacement of the steam machinery with diesel engines of a suitable power, and the modification of the hull form to attain 26 knots.

Taking into account the size of *Roma* and the characteristics of aircraft carriers then in service with some foreign navies, Gagnotto claimed that his design work had three sources of inspiration: HMS *Furious,* the Japanese fleet aircraft carriers for which data were available, and the earlier study for converting Italian steamers. He therefore opted for a 'step' configuration that included two separate flight decks, the lower flight deck being a forward prolongation of the hangar deck. The 162.5-metre upper flight deck had sufficient length for rapid recovery, and would have a round-down aft to smooth the flow of air over the deck. Again, the first phase for implementing the *Roma*/Gagnotto project was the demolition of *Roma*'s upper decks, funnels, the short forecastle and the after deckhouse. The original straight stem would be replaced by a clipper bow, while the after section would be remodelled to improve hydrodynamic efficiency; other structural changes would include new watertight bulkheads and longitudinal reinforcements. The forward and after sections of the four lower decks would be reconstructed and merged with their central sections. A two-level box structure would be erected on the new weather deck to provide the flight deck and the hangar.

Ansaldo had already studied possible changes in the hull length by carrying out tank tests. It was proposed to add 8.5 metres at the bow and 4.5 metres at the stern; beam would remain unchanged in order to increase the length-to-beam coefficient and thus facilitate higher speeds. The hangar deck would coincide with the former 'Deck C' of *Roma*, in order to avoid locating it too high above the ship's centre of gravity with a consequent negative effect on transverse stability. The flight deck had neither catapults nor arresting wires and its length was considered sufficient to operate heavy embarked aircraft. Its surface would be covered with wooden panels with a thickness of 50mm to ensure a degree of thermal isolation in the spaces below and give greater elasticity to the structure when subject to the stresses caused by landing aircraft.

The flight deck was supported by a lattice structure 2.3 metres high, partially closed at the stern and at the bow to include the bridge, the radio room and the fire control spaces. Two long catwalks equipped with nets for personnel recovery were placed on both sides of the flight deck, about one metre lower. Two aircraft lifts 10m x 12m placed on the centreline allowed the movement of aircraft between the hangar and the flight deck; four smaller lifts were to be used for ammunition and bombs. The hangar was 165 metres long, 19 metres wide and 5 metres high; it was closed at the sides by longitudinal plates reinforced by the lattice structures and equipped with large windows to provide ventilation and light. This configuration allowed the hangar to contribute to longitudinal hull strength and provide sufficient space to the sides for weapons and service boats.

The hangar was closed at both ends by two large sliding doors mainly envisaged for protection against atmospheric agents. The lower flight deck, which was effectively a forward extension of the hangar deck, was 60 metres long and equipped with two fixed pneumatic catapults, inclined 15° to port and to starboard of the ship's axis and, according to Gagnotto's report, intended 'to launch seaplanes or heavier aircraft'. This 'auxiliary' flight deck could in fact have been used by any type of embarked aircraft; the catapult rails were recessed into the deck so as not to obstruct the taxiing and launching of aircraft that did not need a catapult. On the after wall



The Japanese aircraft carrier *Akagi* at full speed. Her general configuration inspired some of the preliminary studies carried out in Italy in the interwar period. (Fukui Shizuo collection)

of the hangar there were two cranes for recovering seaplanes that could not land on the flight deck.

Three fire curtains divided the internal volume of the hangar into four zones; the two after zones were used to house the larger TBR aircraft (18 planes) and were served by the after aircraft lift, while the two forward zones could accommodate thirty fighters and were served by the forward lift. Inside the hangar there was also space to store eight broken-down aircraft. The hangar sides were occupied by workshops, service rooms, ready rooms, and offices; the central section of the port hangar side was occupied by the exhaust ducts for the diesel engines.

The deck below the hangar deck was designated 'Deck D' and housed mostly messes, galleys, officer quarters and other crew quarters, while 'Deck E' below had additional crew quarters and the machinery spaces. There were three further lower decks (designated 'F', 'G' and 'H'), housing other crew quarters, machinery, auxiliary equipment, fuel, magazines, spares, and aviation fuel (450 tonnes).

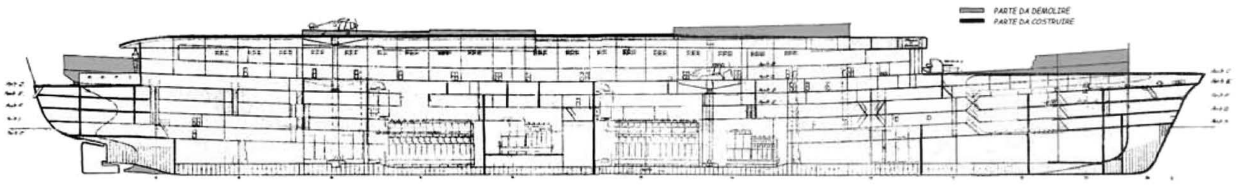
For propulsion, Gagnotto opted for an all-diesel configuration, comprising four diesel engines each developing 13,000bhp. The theoretical total power was 52,000bhp but Gagnotto was confident that during her trials the ship would develop 65,000bhp and reach the designed speed of 26 knots. The four diesel engines were housed in four separate motor rooms in order to meet the requirement for continued operation with three adjacent flooded compartments. The exhausts ducts converged into small funnels protruding from the port upper side of the hull, an arrangement inspired by the Japanese carriers. Fuel stowage was 4,800 tonnes, providing an endurance of 10,000nm at 26 knots.

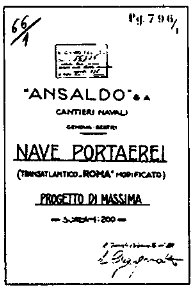
Armament was devoted to anti-surface and anti-air defence and comprised four 120mm twin mounts and four 100mm twin mounts. Fire control was provided from two posts equipped with rangefinders and located at the forward corners of the flight deck. In his report, Gagnotto clearly stated that this preliminary Pg.n.796/Ansaldo project could not include armour protection: underwater protection relied only upon the usual watertight compartmentation and two longitudinal bulkheads at the sides of the machinery spaces. Gagnotto also carried out the stability calculations for four different conditions, the least favourable of which maintained a metacentric height higher than 1 metre.[8]

Complement for the *Roma*/Gagnotto project would

Roma/Gagnotto Project

Length	235.4m oa; 215.4m wl
Beam	25.2m wl
Displacement (trials)	18,400 tonnes light; 25,630 tonnes full load
Depth	27.4m
Draught	7.5m mean
Metacentric height	1.74m
Flight deck	162.5m x 29m
Aircraft in hangar	30 fighters, 18 TBR, 8 broken down
Catapults	Two Gagnotto pneumatic
Armament	Eight 120mm (4 x II), Eight 100mm (4 x II)
Propulsion	4-shaft diesel, 52,000bhp; 65,000bhp max for 26 knots
Fuel stowage	4,800 tonnes
Endurance	10,000nm at 26 knots

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"ANSALDO" S.A.

CANTIERI NAVALI

GENOVA - SESTRI

NAVE PORTAEREI

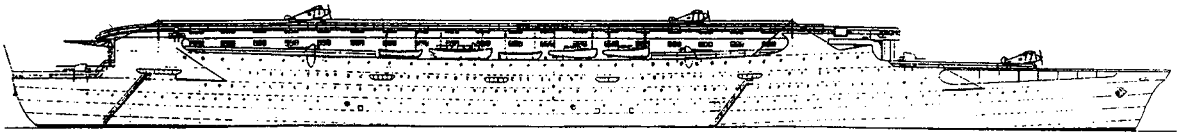
(TRANSATLANTICO „ROMA" MODIFICATO)

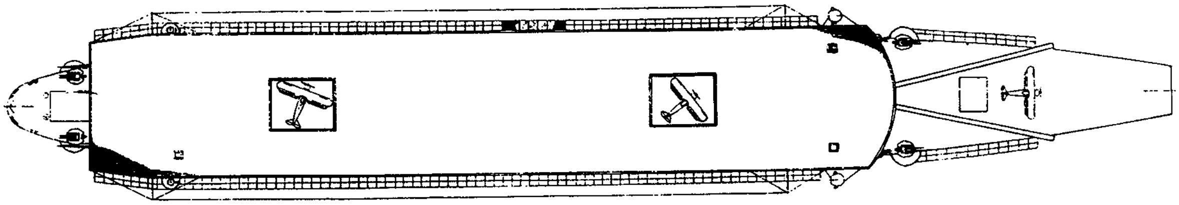
PROGETTO DI MASSIMA

— SCALA 1:200 —

Above: Longitudinal cutaway of the '*Roma*/Gagnotto' project. The grey parts were those to be dismantled, while the thick black lines indicate new watertight bulkheads and the new profile of the bow. (Ansaldo)

Below: Outboard profile and plan of the '*Roma*/Gagnotto' project. It was the result of a cooperation between Colonel Luigi Gagnotto, Naval Engineering Corps, and the Ansaldo company. (Ansaldo)

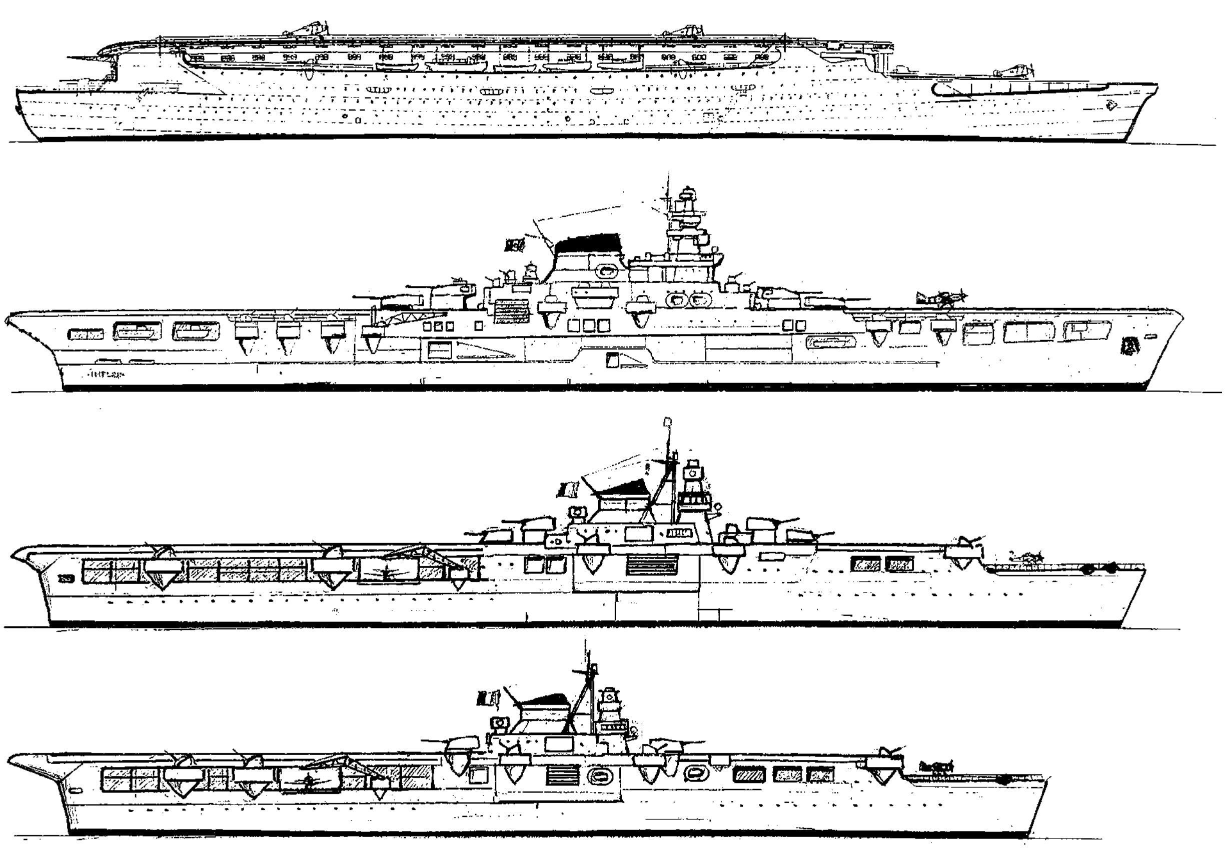




include 776 Navy and Air Force personnel: 76 officers, 100 non-commissioned officers and 600 seamen and airmen. Gagnotto did not provide information on the split between Navy and Air Force officers, but it is safe to assume that most of the pilots, if not all, would have come from the Air Force. The main characteristics of the *Roma*/Gagnotto project are listed in the accompanying table.

The *Roma*/Gagnotto project can best be assessed by comparing it to *Furious* and the Japanese carriers mentioned by Luigi Gagnotto in his report. *Furious* was the result of a conversion carried out in the early 1920s, using in this case the hull of a WWI-era 'light battlecruiser'. *Furious* as an aircraft carrier had 'stepped' flight decks, and was equipped with a double hangar in order to accommodate as many planes as possible. Although *Furious* and the *Roma*/Gagnotto project were similar in size, the British carrier had 36 aircraft instead of the 48 planned for the Italian project but she was faster (31 knots *vice* 26) and had some degree of protection.[9] In his report Gagnotto did not mention any specific Japanese aircraft carriers but it is probable that he took into account *Kaga* and *Akagi*, both of which were conversions of former capital ships not completed to comply with the 1922 Washington Treaty and were given a 'stepped' flight deck configuration. However, the carriers were larger than the *Roma*/Gagnotto project, could operate more planes (60 aircraft) and had a higher maximum speed (28 knots and 31 knots respectively); the Italian project, being powered by diesels, had more range than the Japanese (10,000nm at 26 knots *vice* 8,000nm at 24 knots). *Kaga* and *Akagi* were initially employed to test concepts of air naval operations and both were modified in the 1930s to allow the operation of 90 embarked aircraft.

In principle, the *Roma*/Gagnotto project – the realisation of which was optimistically estimated at about one year – appeared technically similar to what was achieved in Britain and Japan. One unusual feature was the perfect symmetry of the ship, an aspect reflecting Gagnotto's desire to avoid the need to balance an island offset to starboard, thereby reducing the time required by the shipyard for conversion. Another feature was the large number of embarked aircraft which, apart from the performance and availability of suitable planes, represented an important operational factor. The *Roma*/Gagnotto project undoubtedly had a number of weaknesses, the most significant of which was the lack of underwater protection. Another weakness, although not strictly linked to the project, was the high degree of trust placed upon the positive outcome of trials (and the consequent availability) of Italian naval diesel engines; if steam propulsion had been substituted, the arrangement of the funnels would certainly have made flight operations difficult, as experience with the British *Furious* and the Japanese *Kaga* and *Akagi* demonstrated. Nevertheless,



The naval designer Franco Harrauer drew up a number of sketches of possible Italian aircraft carriers. The first from top is the '*Roma*/Gagnotto' project while the others may resemble what Umberto Pugliese had in mind for his 1936 preliminary design.

failure to implement the Gagnotto/*Roma* project represented a further missed opportunity in the historical panorama of Italian aircraft carriers.

It is worth noting that at this time the Italian Naval Staff planned the implementation of two different naval programmes. The first of them was inspired by a scenario in which Italy had to cope with one hostile power, while a second hostile power would remain neutral or benevolent towards Italy. This programme did not require the construction of aircraft carriers. The second programme was more ambitious and aimed to create a so-called 'break out fleet',[10] able to operate also outside the Mediterranean and including three aircraft carriers. Neither of these programmes materialised, and in 1938 Cavagnari firmly stated in the Italian parliament that Italy was '*a natural aircraft carrier bestriding the Mediterranean*'. Because of this the *Regia Marina* was condemned to suffer tragic losses before taking a firm decision to construct an aircraft carrier; but that is a story which will be addressed in Part II of this article.

Endnotes:

[1] See Michele Cosentino, 'The Bonfiglietti Project: An Aircraft Carrier for the Regia Marina', *Warship 2015*, 44–61.

[2] The choice of wording is very important in this official Italian definition: aviation *for* the Navy was a totally different concept from aviation *of* the Navy.

[3] The pneumatic catapult equipping these cruisers had been designed and tested by Gagnotto.

[4] These were the famous 'Fleet Problems', carried out by the US Navy in the 1920s/1930s and focused on the capabilities of the aircraft carriers *Saratoga* and *Lexington*.

[5] Broadly similar in conception and function to the British Board of Admiralty, this committee had been established in 1896 to inform decisions to be taken by the Head of the Italian Navy in all naval matters. It was chaired by the Minister/Chief of the Naval Staff and formed by the most senior admirals and their counterparts in the Naval Engineering and Naval Weapons Corps.

[6] Pugliese listed the British *Argus*, *Hermes*, *Eagle*, *Furious*, *Courageous*, *Glorious, Ark Royal*; the US *Langley*, *Saratoga*, *Lexington*, *Ranger*, *Yorktown*, *Enterprise*, *Wasp*; the Japanese *Hosho*, *Akagi*, *Kaga*, *Soryu*, *Ryujo*, *Chitose*; and the French *Béarn*.

[7] Enrico Cernuschi, 'Il Progetto Roma', *Storia Militare* No 50, November 1997, Ermanno Albertelli (Parma, Italy).

[8] In normal operational conditions, the metacentric height would be 1.74m. In his report, Gagnotto stated that this figure was more than adequate for 'an aircraft carrier that should remain as stable as possible during aircraft landings'.

[9] In 1938 *Furious* underwent a further conversion to incorporate lessons learned, and was employed successfully during the Second World War.

[10] Enrico Cernuschi and Vincent O'Hara, 'The Breakout Fleet: The Oceanic Programmes of the Regia Marina, 1934–1940', *Warship 2006*.

ON BARREN, HIDEOUS ROCKS

The Grounding of HMS *Dauntless*, July 1928

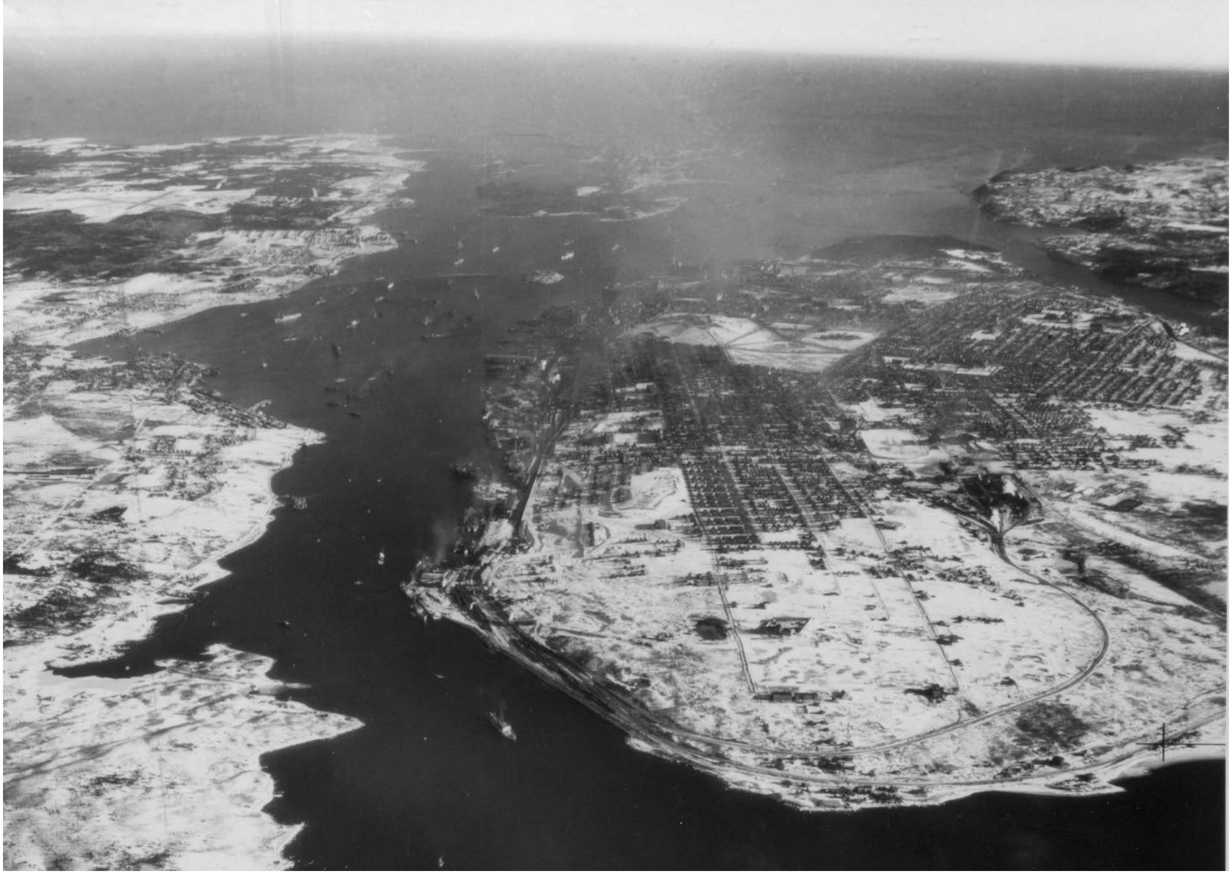
Canadian historian **Michael Whitby** looks at the grounding of the RN light cruiser *Dauntless* on Thrumcap Shoal and the subsequent enquiry.

Maritime calamities have an inherent sadness to them. The grounding of the cruiser HMS *Dauntless* off Halifax, Nova Scotia, in July 1928 was no exception. No lives were lost nor were any sailors injured, but a valuable warship required costly repairs that took months to complete. Long-laid plans were disrupted, and promising careers derailed. Widespread press coverage of the grounding, as well as the fact a modern warship lay impaled on a reef in full view of a major city for ten days, embarrassed the Royal Navy. Often, the causes of such incidents are complex and difficult to divine; however, in this instance, after a few moments of bewilderment, the reason for the grounding became startlingly apparent. Due to its straightforward nature, the Navy did not derive any great contemporary or historical lessons from the affair, and it carried on as before. What emerges, then, is a narrative that recalls the vagaries of naval service in the days before advanced navigational aids such as radar, radio beacons and echo sounders, and one that reveals elements of the worst and best of seafaring.

HMS *Dauntless*

A light cruiser of the *Danae* class, *Dauntless* had a busy first decade. Commissioned within days of the 1918 Armistice, she participated in the Baltic campaign against

An immaculate *Danae* class cruiser, possibly *Dauntless*, during the celebrated Empire cruise of the Special Service Squadron in 1923-24. Captain Macpherson and his ship's company anticipated a similar grand entrance into Halifax. (Department of National Defence)



An aerial view of Halifax harbour in 1941, looking south-east from the entrance of Bedford Basin. Apart from the many ships in harbour awaiting convoy and the unseen harbour defences, nothing significant would have changed from July 1928. *Dauntless* approached from top right intending to keep low-lying McNabs Island, partially obscured by haze at top centre, to starboard. The cruiser grounded to south of McNabs at top right centre. The city of Halifax is at centre, with HMC Dockyard situated midway down the harbour front north of the numerous commercial jetties. Dartmouth Cove, where *Dauntless* was beached after being salvaged, is directly across the harbour from Halifax at the head of the large inlet at the top left. (Department of National Defence REA414-62)

the Soviets, followed by service in the Atlantic and Mediterranean fleets as well as with the Special Service Squadron on its celebrated Empire Cruise. Recommissioned in May 1928, *Dauntless* joined the America and West Indies (A&WI) squadron, one of the most popular in the Royal Navy. Andrew Cunningham, Flag Captain to the Commander-in-Chief (C-in-C) at that time, recalled that it was not uncommon to have three or four times the number of the sailors required volunteering for ships assigned to the A&WI, resulting in a superior ship's company.[1] With officers selected to be diplomats as well as sailors, that quality carried over into wardrooms, and was reflected by the two protagonists in the drama that follows.

Captain Kenneth Douglas Worsley Macpherson, who had taken command of *Dauntless* in February 1927, seemed destined for flag rank. After qualifying as a navigation specialist prior to the First Word War, he was Navigating Officer in the battleship *Vengeance* in the Dardanelles campaign, followed by the same appointment in *Dreadnought* when she was flagship of the 3rd Battle Squadron. Promoted Commander in December 1917, he served as executive officer of the battleship *Centurion* before going ashore to fill two important positions as War Staff Officer at Chatham, then as Commander of the Devonport Barracks. Macpherson was promoted Captain on 30 June 1925.

Dauntless' Navigating Officer, Lieutenant-Commander (N) Thomas Ramsay Beatty – no relation to Admiral of the Fleet Sir David Beatty – had also shown considerable promise. As a junior officer he served in battleships and cruisers of the Grand Fleet, before becoming the First Lieutenant of two destroyers. In 1920 he qualified as a specialist 'N'. Before joining *Dauntless* in February 1928, he was, in turn, Navigating Officer of the lead ship of the 1st Destroyer Flotilla and the aircraft carrier *Hermes* in the Mediterranean Fleet. In terms of navigation, therefore, *Dauntless* appeared in steady hands when she set out from Bermuda in the last days of June 1928 for a show-the-flag tour of Canadian and American ports on the Atlantic seaboard, opening with a port visit to Halifax, a thriving maritime centre and naval base on the south coast of Nova Scotia.[2]

When *Dauntless* approached Halifax in the early hours of Monday 2 July 1928, she became enveloped in the dense fog prevalent in the region during the summer months. With the harbour entrance guarded by what one officer described as 'barren, not to say hideous, rocks', this bred caution.[3] At 0700, with the murk so thick bridge personnel could hardly see the length of the ship, Captain Macpherson decided to postpone entry into Halifax, and anchored south of Devil's Island outside the main shipping lane. While Macpherson waited for the fog to lift, *Dauntless*' sailors cleared for Divisions, took exercise, then went about their normal work routine. Around 1245 'the fog cleared somewhat', enabling Macpherson and Beatty to determine their position relative to Devil's Island Lighthouse and several nearby buoys. Based upon that reckoning, and the knowledge that fog usually thinned the farther one went up Halifax harbour, at 1310 Macpherson decided to get under way.[4]

Neither Macpherson or Beatty had entered Halifax before. However, from a navigational perspective, despite the rocky coastline, transiting the approaches into the magnificent harbour posed no great challenge.[5] From *Dauntless*' position south of Devil's Island, the cruiser would proceed southwest past Portuguese Shoal to the Inner Automatic Whistle Buoy to pick up the main shipping lane, then head north-northwest leaving Neverfail Shoal Buoy to starboard.[6] She would then continue past McNabs Island and around Georges Island into the inner harbour. The seven-mile route was well-marked and familiar to warships of the A&WI, but fog complicated matters immensely. To meet the challenge, Macpherson and Beatty followed routine procedures:

> Quartermasters were in both chains, the sounding party was sounding upon the port machine, special sea-dutymen were at their stations, look outs were placed high up and low down and on both sides…The syren [sic] was sounding in accordance with the rules of the road.[7]

A fog lookout stood watch in the eyes of the ship, and since special sea dutymen were closed up, the cable party provided additional observers on the forecastle.[8] With vision impaired by the dense fog, ears would be as important as eyes for lookouts and watchkeepers who listened for the moaning of fog horns, the clanging of bell buoys or the sound of approaching vessels. Macpherson also 'had very clearly in mind the possibility of shipping and perhaps a good deal of shipping, having, similar to ourselves, weighed when the fog lifted and being on their way down harbour.'[9] Under the circumstances, Macpherson planned to proceed cautiously from buoy to buoy, 'and if in doubt about the safety of proceeding, owing to the fog becoming thicker or any other reason, the ship was to be anchored until it appeared safe to go up harbour.'[10]

After reviewing the navigational plan with Beatty, Macpherson weighed and shaped a course of 245° at eight knots to pick up the Inner Automatic Whistle Buoy. Fifteen minutes later, with the fog thickening, '4 blasts were heard on the port bow', signifying the approach of a vessel:

> This fog blast signal was repeated several times. Our own fog signals were going and the interval between them shortened.

The vessel 'persisted in approaching', causing Macpherson to stop engines, then go full astern to take all way off the ship. A three-masted pilot schooner moving under power finally emerged from the mist to cut close under *Dauntless*' bow. Once clear, the culprit altered to port and 'disappeared into the fog' on the same course as the cruiser.[11] The close call heightened awareness on *Dauntless*' bridge, but Macpherson continued into the murk.

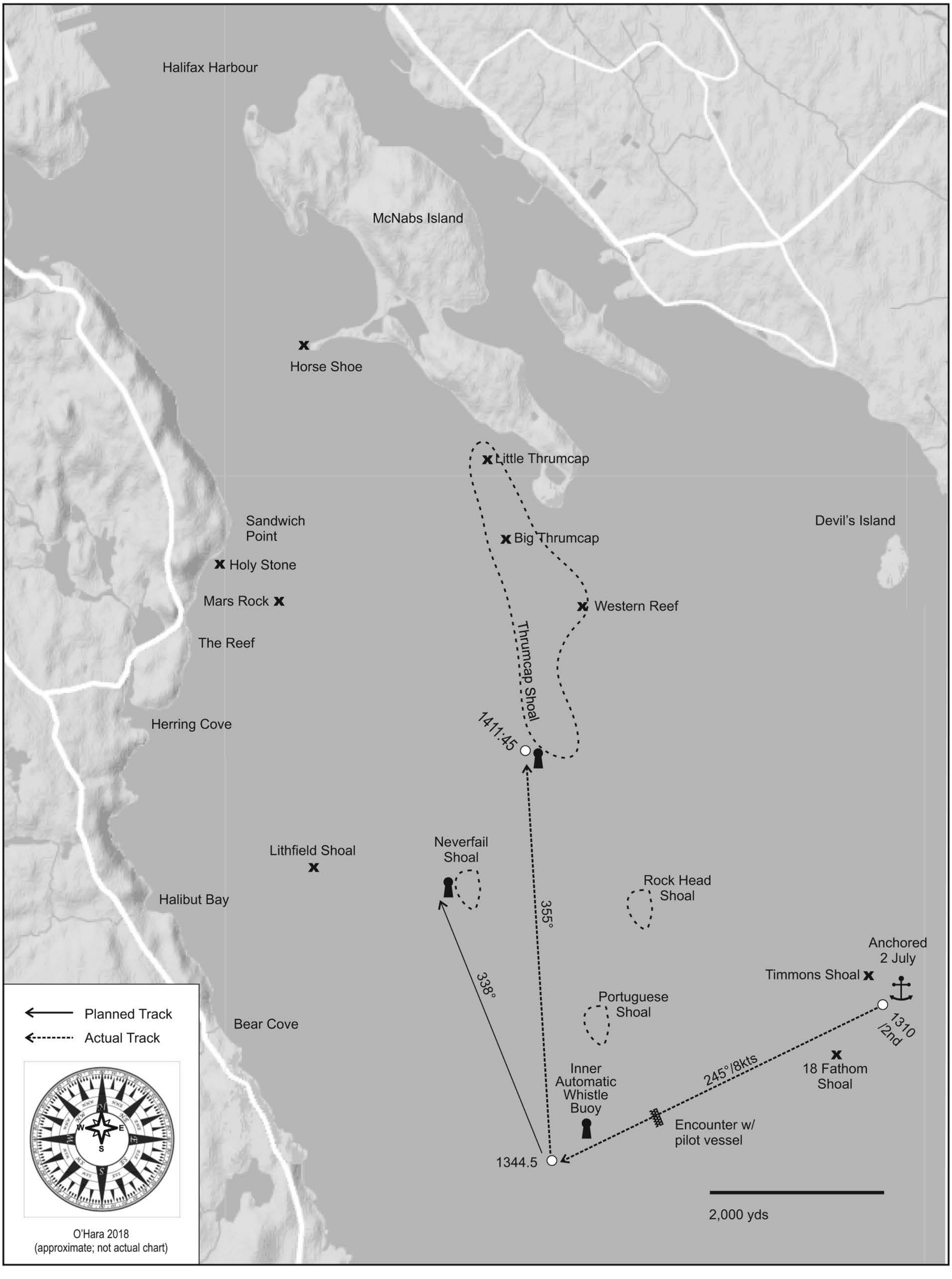
Fifteen minutes after this encounter, the Inner Automatic Whistle Buoy could be heard on the starboard bow. Macpherson turned towards, and Beatty initiated the manoeuvre into Halifax's main shipping channel:

> When I saw we were passing within a cable of [the] Whistle-buoy, I went to the chart hood and drew a line parallel to our prepared course, at a distance of a cable from the buoy, and wrote against it the figures 355. I asked the Captain, as far as I can remember, if the ship could be steadied on 355, and told the Officer of the Watch to do so. He reported the ship steadied on 355 and I examined the Gyro compass to verify this and looked at the standard compass to see that the magnetic course corresponded to that necessary for 355 True.[12]

By this time, the cacophony of maritime sounds reverberating around *Dauntless* was almost as enveloping as the fog. Beatty recalled:

> It was very noisy on the bridge. The siren was going, Chebucto Head Diaphone could be heard the whole time. The soundings were being called out from three positions. The Pilot schooner was making four blasts and the Whistle buoy was audible most of the time.[13]

Dauntless' next mark was Neverfail Shoal Buoy, just over two miles away, which Beatty intended to leave to starboard. When it had not made its expected appearance by dead-reckoning at 1357, Macpherson stopped the ship. However, when a bell was immediately heard to starboard, he continued on 355° at five knots. At 1406, the cable party in the eyes of the ship, who could see under the fog, sighted the buoy on the starboard bow; those on the compass platform only picked it up when it was almost abeam. The colour of buoys is an important tool in confirming their identity, and Neverfail Buoy was multicoloured, red and black. Bridge personnel could not discern the buoy's colour through the murk, but from the forecastle, Lt-Cdr (G) Dennis Lees reported it was chequered. When a sounding of five fathoms was reported, Macpherson and Beatty, standing together on the bridge, agreed 'We had found Neverfail shoal


Halifax Harbour
McNabs Island
Horse Shoe
Little Thrumcap
Sandwich Point
Big Thrumcap
Holy Stone
Mars Rock
Western Reef
Devil's Island
The Reef
Thrumcap Shoal
Herring Cove
1411:45
Lithfield Shoal
Neverfail Shoal
Halibut Bay
355°
Rock Head Shoal
Anchored 2 July
Timmons Shoal
338°
Portuguese Shoal
1310 /2nd
Planned Track
Actual Track
Bear Cove
Inner Automatic Whistle Buoy
245°/8kts
18 Fathom Shoal
Encounter w/ pilot vessel
1344.5
2,000 yds
O'Hara 2018
(approximate; not actual chart)

Map Showing the Course Taken Prior to the Grounding (Drawn by Vincent O'Hara) alright.'[14] They manoeuvred to leave the buoy to starboard, putting on half ahead to help the turn since the cruiser was almost stopped. It was about half an hour before low tide.

Two minutes later, at 1410:45 on 2 July 1928, *Dauntless* shuddered aground.[15] Consternation and bewilderment etched the faces of Macpherson and Beatty. According to the charts and pilot book, as well as the experience of other cruisers that had made frequent entries into Halifax, there should have been plenty of water under the keel on Neverfail Shoal. However, *Dauntless* was not at Neverfail: due to a simple yet appalling blunder on the part of the Navigating Officer, overlooked by the Captain, the cruiser was well east of her intended track and on Thrumcap Shoal, acknowledged 'as one of the principal dangers at the entrance of the harbour.'[16]

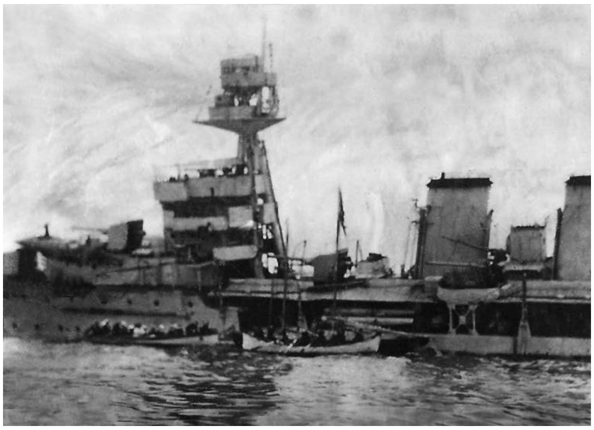
The Grounding

Beatty's revised plan for entering Halifax should have gone without incident. He charted *Dauntless*' path from her location at anchor to the Inner Automatic Whistle Buoy, then plotted a course of 338° to Neverfail Shoal Buoy, followed by a turn to 355° to head up harbour. However, when turning at the whistle buoy, Beatty inexplicably told Macpherson to follow 355° instead of 338°; thus, *Dauntless* proceeded 17° east of her intended track, headed for Thrumcap Shoal not Neverfail. With insufficient clearance at Thrumcap, *Dauntless* grounded. Beatty later explained:

> On passing the Whistle Buoy closer than my prepared track to Neverfail Buoy on the chart, I laid off a line parallel to it and apparently read the figures 355° as referring to this course. In reality they referred to the course for the 2nd leading marks [from Neverfail Shoal], but were written between this line marked on chart and my prepared courses. These figures had been written in by me in pencil, as the printed numbers showing the direction of the leading marks were printed at an unreadable angle.[17]

Beatty had misread his own chart. Years later, another account shed light on what may have occurred. Lt-Cdr Joseph Heenan, RNR, encountered Beatty in Halifax soon after the grounding and 'had a long chat with him as sailors are wont to do':

> He told me that the *Dauntless* arrived off Chebucto Head in thick fog, so they lay off there until the fog temporarily lifted when he got a good fix and then proceeded into harbour. Whilst taking the fix, he layed off the courses into harbour and put them on a chit of paper. Unfortunately, the fog again descended, but he was sure of his position and with caution continued. On picking up Thrumcap Shoal, he mistook it for the fairway buoy and starboarded right into the Shoal. It was not until later that he realized that he had steered the wrong course, taken from the chit of paper he held in his hand on the bridge.[18]



The grounding became front page news in Halifax. This cloudy image from the Halifax *Daily Star* was taken the evening of the mishap as the bulk of the crew left the cruiser. (*Halifax Daily Star*, Author's Collection)

Either way, Beatty had the information he needed at hand. Macpherson's reaction to his navigator's explanation of why his ship went aground is unrecorded.

Even though *Dauntless* had taken the wrong course, accurate identification of the buoys could have prevented the grounding. As described in the pilot book and Beatty's chart, a chequered red and black buoy marked Neverfail, while Thrumcap's was solid red. As recounted above, Lt-Cdr Lees reported from the forecastle that the buoy was chequered. Lees made that identification by unaided eyesight; however, when he acquired binoculars soon after – it appears Beatty had them sent down to the forecastle – he saw that the buoy was red. He hailed that information to the bridge about two minutes before *Dauntless* touched ground, but his report was misinterpreted.[19] Macpherson recalled:

> I think the words of the second report were 'It is red Sir', this I did not at all take as qualifying the previous report that it was chequered, but that there was red in the colour. I was, if anything, a little more satisfied than before because I knew that there was red in the colour of the Neverfail Buoy.[20]

If the imprecision of Lees' report – he later said patches of rust made the buoy appear chequered – did not directly lead to an incorrect assumption by Macpherson, it certainly contributed to one. Of course, had the cable party been equipped with binoculars in the first place, the incident might well have been prevented.

In the days after the grounding, A&WI staff officers who congregated on Halifax received reports that the buoys had been difficult to identify. In a letter to the Halifax Harbour Commission the C-in-C A&WI advised:

> A most noticeable defect in the aids to Navigation in the approaches to Halifax as compared to other ports is that the colours of the buoys are very hard to distinguish.

> The important buoys are all of the cage or framework variety, and it is this that renders it very difficult, unless very close to, to distinguish the colours.[21]

This was disputed by officials in Halifax. Their inspection confirmed that Thrumcap Buoy was 'well coated with red paint, and although considerably weathered there did not appear to be any possibility of mistaking it for a middle ground buoy [like Neverfail].'[22] Another official explained:

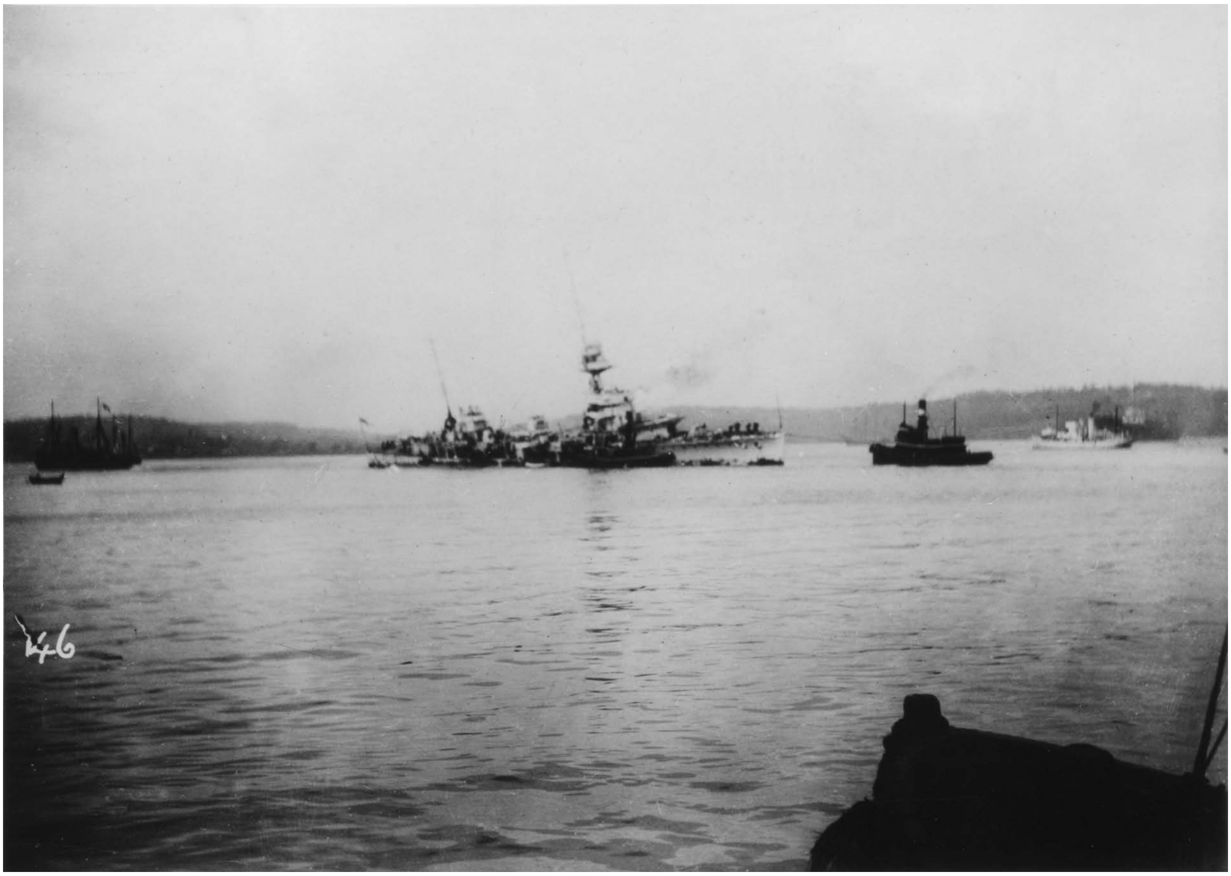
> The type of buoy used in Halifax Harbour is universally used throughout the world with the exception of some of the ports in Great Britain. No complaint of the nature alluded to has ever been received from any pilot or navigating officer frequenting Canadian ports. I can appreciate the difficulty, however, in determining the particular colour of the buoys and can easily understand that a navigating officer who is a stranger to the port and not using the services of a pilot, would find it advantageous to have the colours more clearly defined.[23]

There is no evidence Macpherson considered using a pilot; nor that senior officers ever criticised him for not doing so. In regard to the buoys, although harbour officials thought they had set the record straight, the subject did not go away.

The Attempt to Refloat

Macpherson put on full astern immediately upon *Dauntless*' grounding to try to get her off the rocks. When that had no effect, he requested Canadian naval authorities send tugs. After their initial attempt failed, Macpherson wired 'Send out all available tugs, I consider the position of the *Dauntless* precarious.'[24] Although the cruiser sustained little damage when she 'grounded gently', her wounds intensified as she bounced on the shoal, worked by the tide and wind. Eventually, a rock pierced her hull, penetrating some two feet into a boiler room. The breach caused serious flooding from the stem to amidships, including boiler rooms, fuel bunkers and magazines, and *Dauntless* took on a list to starboard.[25] Macpherson realised:

> The heavy working of the ship in the swell appeared likely to cause the ship to break her back during the night. There were no lights or power in the ship and no work on which the majority of Ship's Company could be employed.

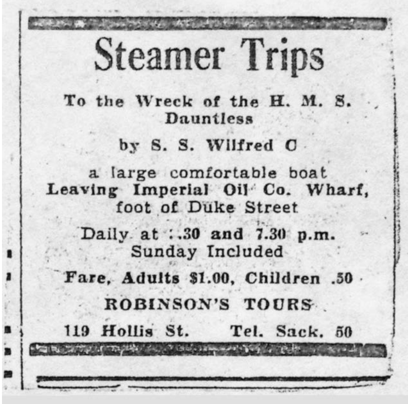


Dauntless aground on Thrumcap Shoal three days after the grounding. Efforts to lighten the cruiser are well under way, with the funnels and most of the main armament already removed. With the exception of the light grey RCN 'Battle' class naval trawler standing by to the right, the vessels are from local Halifax shipping firms. (Department of National Defence CN-6717)

Just before dark he ordered the ship's company taken off with the exception of eleven officers and 27 men.[26]

Macpherson had to lighten *Dauntless* to get her off Thrumcap Shoal before she was battered into a total constructive loss. This required close cooperation with HMC Dockyard Halifax, which placed enormous stress upon the fledgling organisation. The relatively tiny Royal Canadian Navy (RCN) was only in its 18th year, and although the dockyard had existed for decades under British auspices prior to Canada taking it over in 1907, it was thinly manned due to limited resources. That summer the dockyard and naval barracks comprised a mere 23 officers and 105 sailors; another two officers and 40 sailors formed the ships' companies of HMC Ships *Ypres* and *Festubert*, two 'Battle' class naval trawlers that provided the RCN's only seagoing strength on the Atlantic coast. To make matters worse, the Senior Naval Officer (SNO) Halifax, Commander Victor Brodeur, RCN, was bed-ridden with pleurisy, leaving the relatively inexperienced Lt-Cdr Howard Reid, RCN, in charge. Under these circumstances, organising *Dauntless*' sailors was challenge enough; hauling a large warship off a reef was of another order entirely. Fortunately, the besieged dockyard organisation could call upon Halifax's well-developed commercial shipping sector for assistance; given an opportunity for salvage money, these enterprises responded with enthusiasm.[27]

Work to lighten *Dauntless* began in earnest on Tuesday 3 July. Her anchors and chains were released and buoyed for later recovery and, over the next few days, civilian and naval personnel hauled off stores from below as well as equipment and weaponry from the upper deck. Anything remotely transportable was removed. The derrick scow *Lord Kitchener* lifted off *Dauntless*' guns and torpedo tubes, and the process was repeated with other materiel, including the funnels. Of the objects brought up from below, much of the ammunition was found to be contaminated by oil or sea water, and some 564 charges deemed beyond restoration were dumped at sea. Some of the salvaged materiel went into temporary storage, while other, including 300 gallons of rum, was transferred to RCN books.[28] Not all aspects of the operation were above board. The recently-commissioned cruiser had a fully-stocked wardroom bar, and with Prohibition in effect in Nova Scotia, the Army officer's mess at Halifax purchased it to replenish their dwindling liquor supply. An open transaction was illegal, so the soldiers concocted a plan whereby they would unload the liquor into an ambulance and smuggle it past the Royal Canadian Mounted Police guard at the dockyard gate. All went according to plan until the ambulance was hijacked in the streets of Halifax after it left the dockyard, and rum runners hawked the bounty to thirsty locals. An RCN veteran recalled, 'Who hijacked the ambulance is a mystery but I'm afraid there was a bit of leg-pulling by the Halifax N[aval] O[fficer]s when the khaki lads had to pay for a lot of duty free booze they weren't able to drink.'[29]



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Dauntless

by S. S. Wilfred C

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With *Dauntless* the focus of attention for Haligonians this enterprising entrepreneur ran twice-daily tours to the wreck. The Duke Street wharf was adjacent to the commercial centre of Halifax. (courtesy Halifax Naval Museum)

The liquor hijacking escaped public notice, but that did not apply to much else related to *Dauntless*' grounding. From the moment the incident occurred, it captured the fancy of Haligonians, and local newspapers fed their appetite for information with detailed coverage. The day after the wreck, for example, the Halifax *Daily Star* interviewed the local diver hired to survey the damage. DB Beaudry reported:

> The hole is more than thirty feet long and several feet wide and in the centre a jagged ledge of rock is sticking up into the engine room. The rock is acting like a pivot and the boat is grinding down on it. Every swell makes it a little bit worse as the plates which are more than an inch and a half crumble away.[30]

Other stories lionised the work of the tug captains to the point they became local heroes, and at least two newspapers queried why a local pilot had not been utilised for *Dauntless*' passage up harbour. After a few days of this sharp, unremitting focus, unidentified 'naval authorities' clamped down on the release of information.[31] While protesting against this perceived assault upon the freedom of the press, editors continued their coverage; the wreck, after all, lay in full view. Interest never waned, and one local entrepreneur even ran boat tours to the site. As far as Halifax was concerned, *Dauntless* was the star of the summer of '28.

Salvage

Despite the cruiser being lightened, attempts to refloat her continued to fail, even with the injection of compressed air into hull compartments. The picture changed in the evening of 4 July when fresh leadership blew into Halifax. Admiral Sir Walter Cowan had been preparing to see out his last two weeks as C-in-C of the A&WI quietly in Bermuda, but upon learning of the grounding he immediately set out for Halifax in his flagship HMS *Despatch*. On the way up harbour after a fast passage, Flag Captain Andrew Cunningham nosed in *Despatch* for a close look at their sister ship:

> Things were looking pretty grim for the *Dauntless* when we first saw her, and I never thought she would take the

> sea again. She was pounding heavily in the swell and holed in the engine room and one boiler room, listing over and covered with escaping fuel oil. To seaward in the clear water we could see the huge boulders over which she had drifted. If it came on to blow a gale we thought she must break her back.[32]

While Cowan pondered *Dauntless*' recovery, if that was even possible, regulations decreed he convene a Court of Inquiry. Under normal circumstances this would have occurred almost immediately, but there were no officers of the requisite rank in Halifax to constitute the court – at least one officer had to be of similar rank to Macpherson, and Cunningham now filled that role.[33]

Since Macpherson and Beatty admitted in their report on the grounding that 'the ship had taken a wrong course', the Court of Enquiry that met in *Despatch*'s wardroom at 1400 Thursday 5 July 1928 was a cut-and-dried affair. Cunningham was joined on the court by Commander James Powell, *Despatch*'s executive officer and a navigation specialist, and Commander Arthur Gibson, commanding officer of the sloop HMS *Heliotrope*, which had also arrived in Halifax. Cowan directed they 'hold a full and careful examination into the grounding', and find 'fully to whom, if to anyone, blame is attributable and to what extent.'[34] Under *The King's Regulations and Admiralty Instructions*, the court had no authority to award punishment but could make recommendations in that regard.[35] Macpherson and Beatty faced the closest scrutiny of the seven witnesses that appeared, and questioning focused on the meteorological conditions, the track and timings of the passage up harbour and the identification of the buoys. The proceedings lasted only a few hours, and the board only considered the verdict for about as long as it took to set their findings down on paper:

> We are of the opinion that the grounding was due to a wrong course being steered between the Whistle Buoy off Portuguese Shoal and Neverfail Buoy, and that blame is attributable to:
>
> Firstly, to Captain Kenneth DW Macpherson, for neglecting to Check the Course steered from the Whistle Buoy off Portuguese Shoal to Neverfail Shoal,
>
> Secondly, to Lieutenant-Commander (N) Thomas R Beatty, the Navigating Officer, for ordering the wrong Course to be steered.

The board noted that 'all practicable steps were taken to get the Ship off, and to prevent further damage', and that Macpherson was 'fully justified' in landing his sailors. They made no recommendations as to punishment; however, when the Admiralty endorsed their findings, Courts Martial of Macpherson and Beatty were a certainty.[36]

With that business settled, attention refocused on getting *Dauntless* off the rocks. The fact that no firm in Halifax or elsewhere in Canada's three Maritime provinces was capable of salvaging the cruiser on its own was a major stumbling block. Halifax Shipyards Ltd had some capability but was restricted by the limited towing power of the tugs and salvage vessels available in Halifax. When so informed, Admiral Cowan requested that authorities look outside the region to other Canadian agencies, 'otherwise American firms will be asked but hoped this will not repetition not be necessary.'[37] It turned out the Quebec Salvage Company at Montreal had the required capability; however, federal regulations prevented it from operating outside the St Lawrence River. This must have tried Cowan's legendary temper, and he was forced to turn to the United States after all. Although the longstanding British–American rivalry likely contributed to his reluctance, it was probably more due to the exorbitant costs involved: $8,000 a day, an amount Cowan's Flag Captain considered 'frightful'.[38] Though expensive, the American solution showed promise. The United States Navy contracted salvage operations to a company working out of Boston, which had met success refloating wrecks with pontoons. It was thought this method might lift *Dauntless* off the rocks, and 9 July the salvage steamer *Willett* departed Boston for Halifax with two 80-ton pontoons in tow.[39]

Since a few days would elapse before the Americans arrived, Cowan, still loath to rely upon their services, sought alternatives. On 10 July, he convened a conference of his officers and shipping officials 'to evolve a practical course of action.' Lieutenant-Commander Joseph Heenan, RNR, temporarily appointed to HMS *Despatch*, left a reliable account of what transpired. Captain Cunningham presented a sketch showing *Dauntless*' position relative to Thrumcap Shoal, her list to starboard and the local soundings. What had changed from previous salvage efforts was the availability of *Despatch*'s 40,000shp turbines, which were significantly more powerful than anything else available. 'At first glance', Heenan recalled, 'it was apparent that a careening job was required to heave the ship upright in an endeavour to ease her off the piercing rock which had penetrated one or two feet.':

> After much discussion it was decided to anchor *Despatch* close to and at right angles to *Dauntless*. Pass a strong wire hawser around the highest point of the *Dauntless*, which was the base of the funnels, secure [a] wire hawser to the strongest manila hawser available, the latter to be led through leads on the quarter deck of the *Despatch* and secured around the base of the after gun. The angle between the quarter deck of the *Despatch* and the base of the *Dauntless* funnels was not as steep as could be desired, but the power of the pull would be enormous, and it might just work, if the structure of the ships and hawsers could stand the strain.[40]

If *Despatch*'s muscle could pull *Dauntless* upright, HMS *Heliotrope* and Halifax Shipyard's salvage vessel *Caribou* might be able to haul her clear. The resourcefulness of the plan, apparently conceived by Cunningham, said much about the vast sea-faring experience present in *Despatch*'s flag cabin, and Cowan directed it be put in motion the next day.

The weather remained calm as *Despatch* anchored in position on the morning of Wednesday 11 July. While she ran her hawser across to *Dauntless*, *Heliotrope* and *Caribou* positioned themselves ahead of the stricken cruiser. High water was at 1426. Heenan, who was on *Despatch*'s bridge with Cowan and Cunningham, remembered:

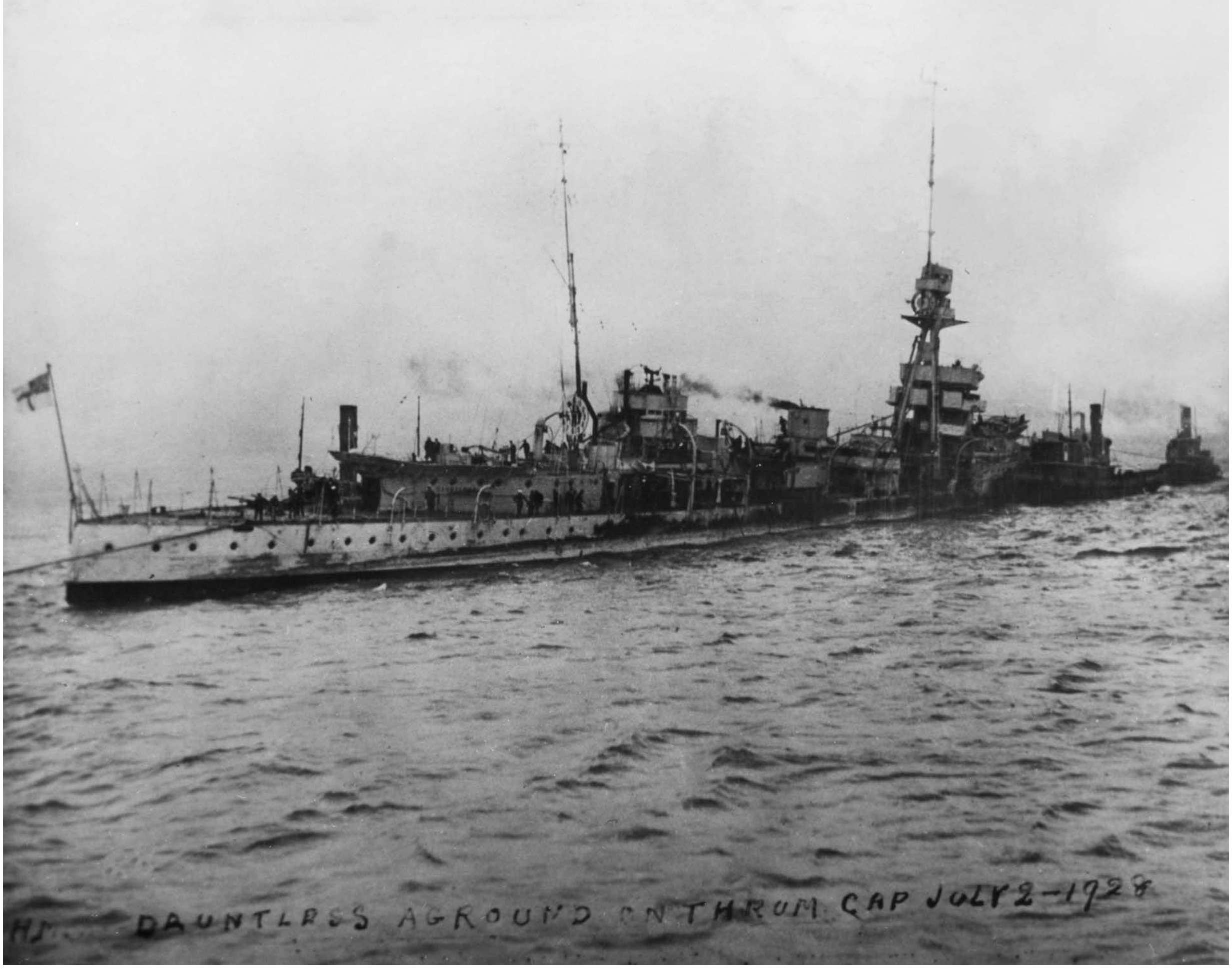
> The plan was as high water approached, *Despatch* would first take the strain by heaving on her anchor, trip it and then gradually work her engines to take the strain gently and thence to the power required. At a given signal from the *Despatch* [the other vessels] were to pull with all their might.[41]

Cunningham described the critical moment:

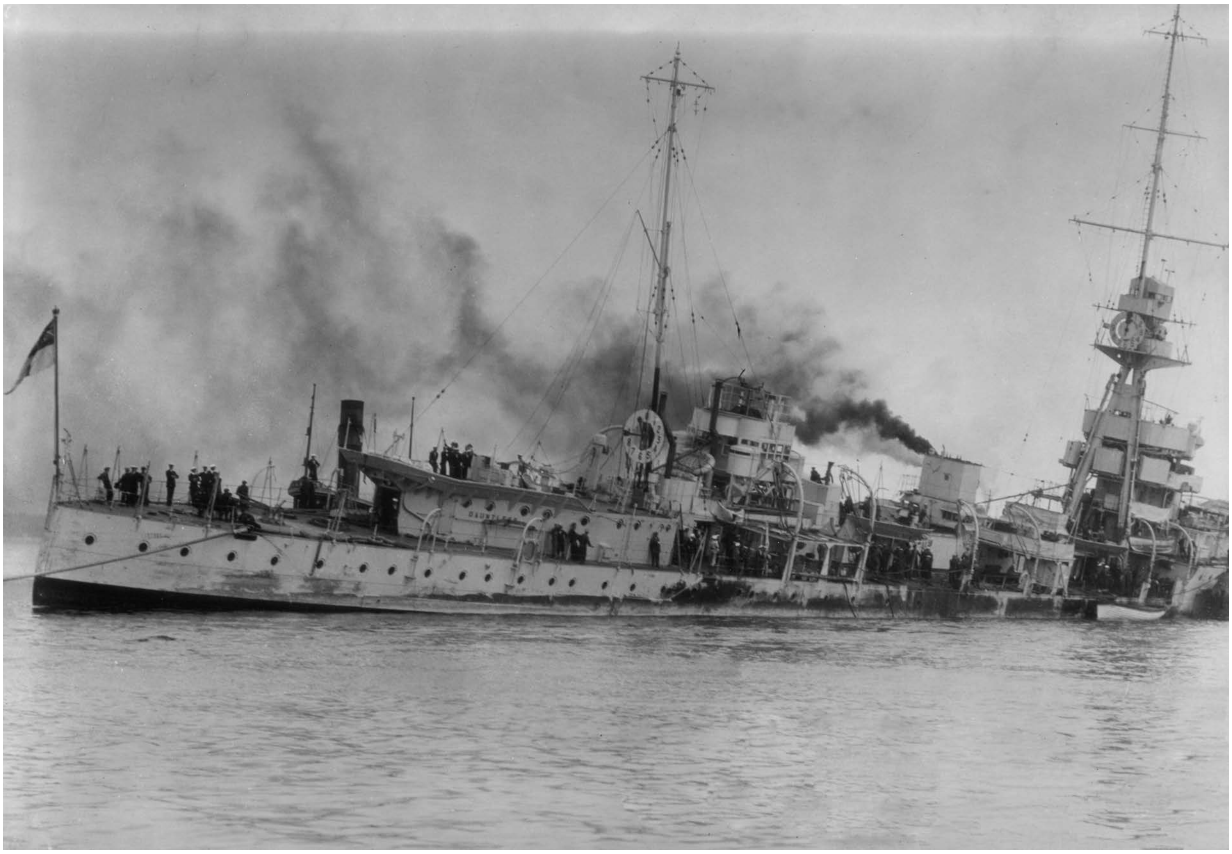
> We gradually worked up speed. Our hawsers came twanging and thrumming out of the water under the heavy strain. We watched them with anxiety; but after a little hesitation the *Dauntless* bumped over the obstructions to seaward and slid off into clear water, afloat once more.[42]

According to the Halifax *Daily Star*, 'hundreds of onlookers and salvagers gave a tremendous cheer as the big warship was seen to move.'[43] Describing a moment of almost unbelievable serendipity Cunningham and Heenan later claimed the *Willett* and her pontoons entered harbour from Boston at the very moment *Dauntless* came free.

Stripped of her weaponry, fixtures and funnels, *Dauntless* presented a sorry sight as she was towed gingerly into Halifax, resembling a hulk more than a modern warship. Since the graving dock at Halifax Shipyards was occupied, she was temporarily beached in Dartmouth Cove across the harbour – although her position remained ignominious, she was at least on safe ground. Two days later she was towed into dock. As Heenan observed, 'Several months and many million dollars later she was restored to operational condition



A bedraggled *Dauntless* before her recovery, but certainly not on 2 July. Some accounts submit this was taken as she was towed up harbour after being pulled off Thrumcap Shoal; however, the absence of personnel on the compass platform suggests otherwise. (Department of National Defence HS-11284)



A tighter image of the same sequence. Note the absence of most heavy fittings. Those personnel left on board seem to be standing by awaiting activity, indicating it may have been taken on 12 July. (Department of National Defence)

again.' Finally, on a February 1929 day that appears to have been as foggy as the day she grounded, *Dauntless* arrived home in Portsmouth.[44]

Dauntless' ship's company had returned to Great Britain months earlier. On 15 July, 350 officers and men departed Halifax in the specially chartered liner SS *Pennland*; a small party of 26 sailors led by Commander Clement Moody and Engineer Commander Peter Warwick remained behind to oversee *Dauntless*' repairs.[45] The cruiser paid off on 1 August. Captain Macpherson, who took separate passage home, was no doubt disconsolate at having to leave his ship behind; however, judging from a personal letter from Admiral Cowan, he could take a measure of pride in his role in saving *Dauntless*. 'My dear Macpherson', Cowan wrote the day after *Despatch*'s departure from Halifax:

> We had no time to spare in getting back here or I should have liked to shake you by the hand after poor *Dauntless* was afloat.
>
> You worked most splendidly at her and set a very fine example in many ways and particularly by the stout-hearted way in which you put all your own feelings on one side and went at the job of doing your utmost to save her tooth and nail.[46]

Although Cowan was undoubtedly genuine in his appreciation, Macpherson would have understood that the letter was also intended to benefit him in the Court Martial that awaited.

The Court Martial

Presented with the unambiguous findings of the Court of Inquiry, the Admiralty proceeded with Courts Martial of Macpherson and Beatty. The charge against both, as per Section 29 of the Naval Discipline Act, was 'negligently or by default [did] suffer HMS *Dauntless* to be stranded.' The courts came under the authority of the Commander-in-Chief Portsmouth where Macpherson and Beatty were appointed after *Dauntless* was paid off. Separate proceedings were held for each officer, but they shared the same board, summoned from officers 'of standing and experience' available in Portsmouth.[47] All held the rank of Captain, and their names engendered respect: Dudley North, Charles Scott, Max Horton, James Salmond, Jack Tovey, Robert Turner, H Hext Rogers and Lionel Wells. Deputy Judge Advocate of the Fleet, Paymaster Captain Herbert Measham, managed the proceedings and provided legal advice, while Captain James Troup was appointed Prosecutor. As commanding officer of the A&WI cruiser HMS *Cairo*, familiar with Halifax and a respected navigator whose next appointment was to command the RN's navigation school, Troup was well qualified for this important position.[48]

The courts sat on consecutive days, with Lt-Cdr Beatty appearing first on 6 August 1928. The report he authored with Macpherson was entered into evidence with the admission the 'ship had taken the wrong course.' During questioning, Beatty confirmed he had taken no precautions to double check if *Dauntless* was following the correct course after she turned to 355° upon rounding the Whistle Buoy.[49] All the defence could do, then, was raise mitigating circumstances, and much of Beatty's testimony concerned the buoys marking Neverfail and Thrumcap shoals. When Troup asked, 'Was the Thrumcap-shoal-buoy at any time before grounding clearly identified and located, and if so by whom?', Beatty responded:

> The buoy sighted shortly before grounding fitted in with the distance run by dead-reckoning from the Whistle-buoy. The shape agreed exactly with the Neverfail-shoal-buoy as charted. The buoy was reported chequered, in other words, of two colours. It was reported from the forecastle as chequered .... The buoy when I sighted it might have been of two colours, as there is a dark patch around the bell near the portion of the framework. From these observations the buoy could quite reasonably be accepted as the Neverfail-shoal-buoy. The soundings obtained on stopping at 1357 agreed with a position southwards of the Neverfail-shoal-buoy, and the sounding taken shortly before grounding from a position a cable Northwards of the buoy, also agreed with the charted depth – one cable Northwards of the Neverfail-shoal-buoy.

Beatty, therefore, thought it was fair to assume he had arrived at Neverfail. When questioned by the 'accused's friend', Lt-Cdr Edward Brook, navigator of the cruiser HMS *Champion*, Beatty added that he received no other reports of the buoy's colour, nor could he distinguish the colour of the occulting light on the buoy – Neverfail's was white, Thrumcap's red. Returning to cross-examine Beatty, Troup subtly exposed the buoy argument. 'I take it then', he queried, 'that at no time before grounding did you notice the similarity between these two buoys?' Beatty admitted:

> In studying, in preparing the chart, I knew there were two bell buoys. I did not particularly compare the Thrumcap with the Neverfail, as I was more concerned about avoiding the Lichfield shoal on the opposite side.[50]

Of course, Beatty did not expect to encounter Thrumcap Buoy; nonetheless Troup thought he should have been prepared for that possibility. He also left the suggestion Beatty had grasped at the buoy issue only after the fact. But it was of no real consequence; no flaw with the buoys, genuine or otherwise, could override the reality that the Navigating Officer had simply taken the wrong course. Nothing could eclipse the original sin. The court found a charge of 'Severe negligence' proved, and Beatty was 'dismissed his ship'.

Captain Macpherson‘s trial took a similar course. The court and officers remained the same, except that Captain North sat as President instead of Captain Wells who had occupied that chair for Beatty's trial. In his statement of defence, Macpherson posed a question to his colleagues:

> … as officers of experience in command of His Majesty's Ships, whether it is not reasonable to place trust in the work of a highly skilled and reliable specialist officer. If it is admitted that it is the common practice to place reliance on specialist officers to carry out their duties efficiently, without constant checking by the Captain, I submit that a charge of negligence or default in this respect is not upheld.[51]

He explained how he had developed complete trust in Beatty, and after the close call when the pilot vessel cut across *Dauntless*' bow, 'the exigencies of the moment were such that I should not have been justified in allowing myself to be distracted by checking the work of my Navigating Officer':

> … The prevailing thick weather, the proximity of this craft and the possibility of other vessels being encountered in the neighbourhood of the main channel kept my attention fully employed and I realised that I must remain in a position ready to take immediate action. The difficulties with which I was confronted in order to avoid collision can be appreciated from the entries in the Log and Engine Room Register, which show that I needed to stop the ship for a period of nine minutes.
>
> When course was altered from Portuguese Shoal Buoy [*sic*] my attention was fully occupied in handling the ship, and I had no reason to suspect that the proper course for making the Neverfail Shoal Buoy had not been set.[52]

As captain he was responsible for all aspects of his ship's safety, and under the circumstances he felt he had no choice but to trust Beatty. Addressing the misidentification of Thrumcap Shoal Buoy, 'I respectfully submit that I took every reasonable and seamanlike precaution to verify this buoy.' Macpherson reminded the court that it was initially reported as chequered, and the subsequent report that it was red did nothing in terms of either the information provided or the tone by which it was delivered to change the initial classification. Finally, with regard to soundings, those 'obtained up to the time of grounding were such as I expected to get on the course to and in the vicinity of Neverfail Shoal.'[53]

Andrew Cunningham was the only witness called by the defence. He used his knowledge of Halifax to provide context to the situation that confronted Macpherson. Cunningham told the court he had also found the buoys confusing:

> I am of the opinion that had I been confronted with one of those buoys in a fog, even after my experience of going into Halifax harbour on several occasions, I should have

> extraordinary difficulty on deciding which one it was, even if I had been able to do so at all.

In light of this testimony, one has to wonder why Cunningham made no mention of any potential issues with the buoys in his July report on the findings of the Board of Inquiry. Moving on to discuss the local conditions at Halifax, Cunningham suggested that, since it was often clear in the inner harbour when the approaches were shrouded by fog, significant traffic could have been coming down harbour into *Dauntless*' path, his clear inference being that Macpherson had his hands too full to double-check the work of a navigator he trusted implicitly.[54]

As with Beatty, the mitigating circumstances introduced by Macpherson failed to sway the court. In about as much time as it took *Dauntless* to get from the Inner Automatic Whistle Buoy to Thrumcap Shoal, they returned with a decision the charges were proven that Macpherson 'did not at any time check the course steered namely 355° the steering of which course was the primary cause of the ship stranding.' Before the court considered punishment, the defence introduced Cowan's letter praising Macpherson's leadership in salvaging *Dauntless*, and Cunningham reappeared to inform the court: 'I think the salving of the *Dauntless* is practically entirely due to the energy and vigour displayed by the accused and the ship's company in the position in which they found themselves.' If this had any impact, it was slight; Macpherson was dismissed his ship and 'Reprimanded', though not 'Severely' like his navigator.

The *Dauntless* courts martial received global press coverage. The *Times of London* account of each trial filled three to four columns that extended over the fold, and reports of the verdicts were published in locales frequented by the Royal Navy such as Bermuda, Singapore and Victoria. Halifax paid particular attention, but there the news caused consternation. Although Beatty never actually made the assertion, press accounts claimed he testified the Thrumcap Shoal buoy 'was incorrectly charted which caused the ship's grounding', creating the false impression that *Dauntless* grounded through no fault of her own.[55] This infuriated Canadian officials, who penned a flurry of correspondence in protest. The Chief Hydrographer of Canada wrote his counterpart at the Admiralty: 'I beg to inform you that Thrumcap shoal is correctly charted and that there is absolutely no foundation for such a report, and I would be grateful if you would take the necessary steps to make this made known.'[56] The Admiralty agreed the accusation was false, but the damage was done. In the public perception, at least, Halifax was thus unfairly assigned a portion of the blame for the incident.

Conclusion

Beyond the fact that the captains of Royal Navy warships undoubtedly hovered over their navigators' charts with increased frequency, no significant lessons emerged from the grounding. Such calamities occurred relatively infrequently, and Beatty's blunder did nothing to shake the Navy's confidence in its navigation training. For example, despite his involvement in the affair, Captain James Troup did not mention it in his respected primer on navigation published six years later.[57] The grounding was an isolated incident, caused by human error, and the Navy moved on.

Importantly, although Macpherson and Beatty received severe and public censure for their failure, the Navy did not write them off. Beatty never again went to sea; however, his expertise was put to use in the meteorological department of the Admiralty, where he served until after the Second World War, rising to Assistant Director. Macpherson had better opportunities, but they also lay outside the mainstream. After serving in the Admiralty's reserve organisation, he commanded the Fishery Protection and Minesweeping Flotilla, and after retirement in 1936 returned to serve as a convoy commodore in the Second World War. Thus, the Navy accrued some benefit from its investment in the two officers, and in recognition of their long service Beatty and Macpherson were promoted, respectively, to Acting Commander and Acting Rear-Admiral on the retired list.

Cunningham's future is, of course, well known, but his role in *Dauntless*' salvage sheds additional light on his considerable talents as a seaman. Like those officers, *Dauntless* also continued a long career. After months in refit and repair, she rejoined the A&WI and went on to provide useful, if unspectacular, service until the end of the Second World War. The RCN also emerged well, and Admiral Cowan wrote a glowing letter of thanks to the SNO Halifax, explaining: 'No sailor can ever have done more for a ship in distress.'[58] Thus, some positive outcomes emerged from the sadness of a shattered warship beset on barren, hideous Thrumcap Shoal.

Acknowledgements:

The author profited from the insights of Commodore Jan Drent and Captain Norm Jolin, both RCN (Ret'd), who made many entries into Halifax; as well as from Captain Gil Lauzon USN (Ret'd) and Vincent P O'Hara, who also generously created the map. Rosalie Spires, and the staffs of the Maritime Command Museum, The Maritime Museum of the Atlantic and the Royal Navy Museum assisted with research, while Leading Seaman Katie Barker, RCNR, prepared the images.

Endnotes:

[1] Viscount Cunningham of Hyndhope, *A Sailor's Odyssey*, Hutchison (London 1951), 121.

[2] Various editions of the *Navy List*, 1913 to 1928.

[3] Captain JAG Troup, *On the Bridge*, Rich & Cowan (1934), 17. Troup made many entrances into Halifax when CO of HMS *Cairo*.

[4] Captain KDW Macpherson and Lieutenant-Commander TR Beatty, 'Report on Grounding', 5 July 1928; and Ship's Log, HMS *Dauntless*, 2 July 1928, both The National Archives (TNA), ADM 156/98.

[5] Descriptions of the buoys in this study are from US Hydrographic Office, *Nova Scotia Pilot*, 1920, and

HF Pullen, *The Sea Road to Halifax*, Maritime Museum of the Atlantic, 1980.

[6] In most documents related to the *Dauntless* grounding, the Inner Automatic Whistle Buoy is referred to as the Whistle Buoy.

[7] Beatty, Court Martial testimony, 25, ADM 156/98. The 'Machine' was a Kelvite Mk IV Wire Sounding Machine, see see collections.rmg.co.uk/collections/objects/42898.html.

[8] Macpherson, Board of Inquiry testimony, 5 July 1928, TNA, ADM 156/98, 5.

[9] Macpherson, Court Martial testimony, 7 August, TNA, ADM 156/98, 104.

[10] Beatty, Court Martial testimony, 6 August 1928, 26.

[11] Macpherson, Court Martial testimony, 104 and 115.

[12] Beatty, Court Martial testimony, 25.

[13] Beatty, Court Martial testimony, 33–34.

[14] Beatty, Court Martial testimony, 31.

[15] Members of the forecastle party saw bottom moments before *Dauntless* grounded.

[16] Nova Scotia Pilot, 253. *Dauntless* was not the only A&WI cruiser to run aground in that era. In August 1922, HMS *Raleigh* grounded in thick fog in the Strait of Belle Isle between Labrador and Newfoundland. Eleven sailors drowned and *Raleigh* was declared a total constructive loss.

[17] Beatty, Board of Inquiry testimony, 5 July 1928, TNA, ADM 156/98, 3.

[18] JA Heenan, 'Grounding of HMS *Dauntless* on Thrumcap Shoal Halifax Harbour, 2 July 1928', 14 September 1961, 2–3, Directorate of History and Heritage (DHH), 81/520 8000 HMS *Dauntless*.

[19] Lees, Board of Inquiry testimony, 7–8.

[20] Macpherson, Board of Inquiry testimony, 9.

[21] Admiral Sir Walter Cowan to Halifax Harbour Commission, 10 July 1928, TNA, ADM 156/98.

[22] Chief Hydrographer, Canadian Hydrographic Service to Admiralty, 3 October 1928, Library and Archives Canada (LAC), RG 42, volume 414, file 130 D7.

[23] A Johnston to Halifax Harbour Commission, 17 July 1928, LAC, RG 42, volume 414, file 130 D7.

[24] *Halifax Daily Star*, 3 July 1928. Tugs made three attempts to free *Dauntless* between 1655 and 2300 – see 'Certified Extract from the Navigating Officer's Notebook', TNA, ADM 156/98.

[25] SNO Halifax to Admiralty, 23 July 1928, LAC, RG 24, volume 5670, file NSS 78-39-2. In terms of structural damage, the port-side boilers had lifted and tilted, the reserve feed tank had been pushed up six inches, three port side strakes were badly corrugated, and the port bilge keel was damaged beyond repair.

[26] Captain KDW Macpherson and Lieutenant-Commander TR Beatty, Report on Grounding, 5 July 1928; and Ship's Log, HMS *Dauntless*, 2 July 1928, TNA, ADM 156/98.

[27] Deputy Minister, Report of The Department of National Defence (Naval Service) For the Fiscal Year Ended March 31, Ottawa, 1929; and Vice Admiral Nigel Brodeur to author, 26 January, 2018.

[28] A/SNO Halifax to Naval Headquarters 4 July 1928; and 17 Aug 1928, both LAC, RG 24, volume 5670, file NSS 78-39-2; and Report of The Department of National Defence (Naval Service) For the Fiscal Year Ended March 31, 19–20.

[29] H Nelson Lay, *Memoirs of a Mariner* (Stittsville, Canada's Wings, 1982), 51; and Rear-Admiral Victor Brodeur ms, *Reminiscences*. Brodeur witnessed the transfer of the liquor into the ambulance from his sick bed.

[30] *Halifax Daily Star*, 6 July 1928.

[31] *Halifax Herald*, 7 July 1928.

[32] Cunningham, *A Sailor's Odyssey*, 136.

[33] Cunningham had six years seniority as a Captain over Macpherson.

[34] Admiral Sir Walter Cowan to Captain Andrew Cunningham, 'Memorandum', 5 July 1928, TNA, ADM 156/98.

[35] Admiralty, The King's Regulations and Admiralty Instructions, Volume I, London, 1926, 487.

[36] Captain AB Cunningham, Commander J Powell and Commander AK Gibson, 'Grounding of HMS *Dauntless* – 2nd July 1928. Finding of Court of Inquiry', 5 July 1928, 1–2; and Admiralty, Director of Navigation minute, 20 July 1928, both TNA, ADM 156/98.

[37] A/SNO Halifax to Naval Headquarters, 5 July 1928, LAC, RG 24, volume 5670, file NSS 78-39-2.

[38] Cunningham, *A Sailor's Odyssey*, 136. In 2017 currency, $8,000 US would be the equivalent of about $110,000 (£78,000 approx).

[39] Heenan, 'Grounding of HMS *Dauntless* on Thrumcap Shoal Halifax Harbour, 2 July 1928'; *Halifax Chronicle* and *Halifax Daily Star*, 9 July 1928; and Captain CA Bartholomew, *Mud, Muscle and Miracles: Marine Salvage in the US Navy*, Washington, 1990.

[40] Heenan, 'Grounding of HMS *Dauntless* on Thrumcap Shoal Halifax Harbour, 2 July 1928'.

[41] Ibid.

[42] Cunningham, *A Sailor's Odyssey*, 136–37.

[43] *Halifax Daily Star*, 11 July 1928.

[44] Heenan, 'Grounding of HMS *Dauntless* on Thrumcap Shoal Halifax Harbour, 2 July 1928'; and A/SNO Halifax to Naval Headquarters, 12 July 1928, LAC, RG 24, volume 5670, file NSS 78-39-2. A British Pathé film clip of *Dauntless*' return to Portsmouth can be found at www.youtube.com/watch?v=krwSKYcDk6k.

[45] A/SNO Halifax to Naval Headquarters, 7 July 1928, LAC, RG 24, volume 5670, file NSS 78-39-2. Commander Clement Moody's role in the episode is absent from the records; however, as executive officer, he would have played an important role in *Dauntless*' recovery. Certainly, there was no blemish on his record, and he retired in the rank of Admiral.

[46] Admiral Sir Walter Cowan to Captain KDW Macpherson, 13 July 1928, TNA, ADM 156/98.

[47] The King's Regulations and Admiralty Instructions, Volume I, 167.

[48] Troup was also a long acquaintance of Macpherson having been on the same Long 'N' course.

[49] Beatty, Court Martial testimony, 32.

[50] Beatty, Court Martial testimony, 24–30, and 32.

[51] Macpherson, 'Statement in Defence', 3–4.

[52] Ibid, 2–3.

[53] Ibid, 6.

[54] Cunningham, Court Martial testimony, 7 August 1928, TNA, ADM 156/98.

[55] *The Times of London*, 'Inquiry into Stranding', 6 August 1928; *Halifax Herald*, 6 August 1928; and *Halifax Chronicle*, 'Buoys Were in Correct Position', 7 August 1928.

[56] Chief Hydrographer, Canadian Hydrographic Service to Hydrographer, Admiralty, 11 August, 1928; Commander HB Taylor (for CNS) to Admiralty, 25 August 1928; and Admiralty to CNS, 20 September 1928, all LAC, RG 42, Volume 414, File 130 D7.

[57] Troup, *On the Bridge*.

[58] C-in-C A&WI to SNO Halifax, 12 July 1928, Maritime Command Museum.

T 47 *SURCOUF*

This short feature showcases the Editor's line drawings of the French T 47 fleet escort *Surcouf* as completed in the mid-1950s. The drawings are adapted from the official plans drawn up by Lorient Naval Dockyard and dated 10 June 1958.

After the end of the Second World War the French Navy was left with a handful of destroyers that had survived the conflict together with a similar number of German and Italian war prizes. An urgent programme of replacement was required, but funding was initially lacking, and port and industrial infrastructure needed to be rebuilt almost from scratch.

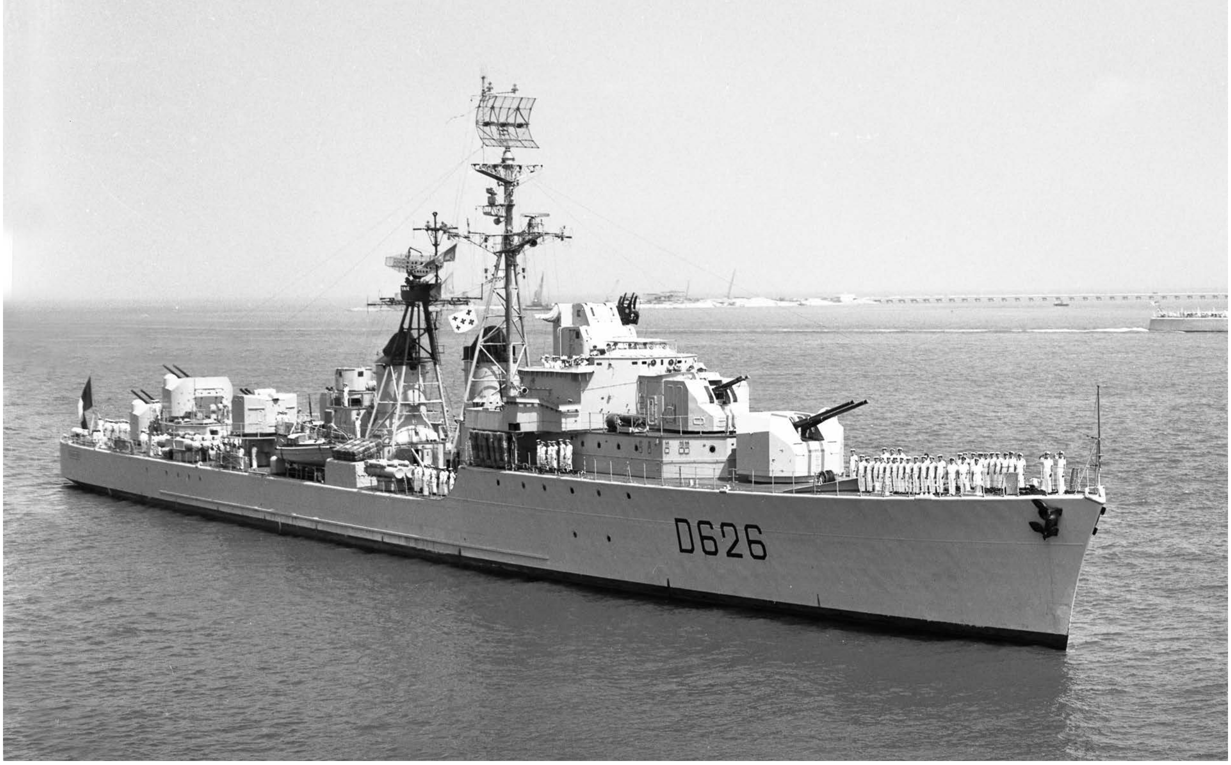
When the French naval staff and corps of constructors first met to consider the new programme in early 1946 they decided on a destroyer modelled on the US Navy's *Gearing*, displacing 2,500 tons standard and armed with six 5in dual-purpose guns in twin mountings. However, unsurprisingly, the ships would end up with a hull-form, propulsion layout and general appearance that reflected earlier French prewar and wartime 'fleet torpedo boat' designs.

A preliminary proposal designated T 47 A was submitted on 8 December 1947, and was followed by alternative variants 'B' and 'C' in February 1948. Design T 47 B was selected for development and the first ship was ordered from Lorient in 1949, but work continued on the design and by the time *Surcouf* was completed in 1954 a number of important changes had been made.

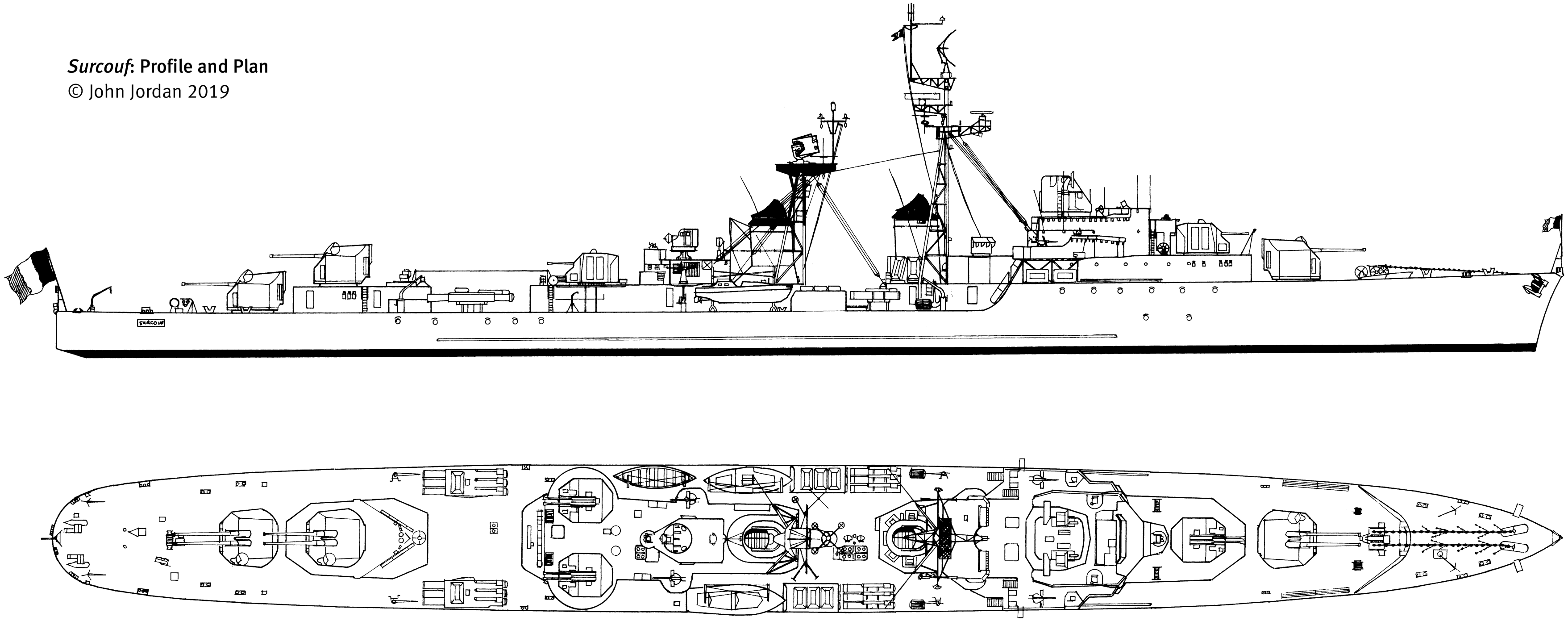
The new ships were intended as escorts for two French task forces, each to be based on a battleship and two aircraft carriers. Initially designated *escorteurs de 1re classe* (1951), then *destroyers-escorteurs*, then *escorteurs rapides* (1954), they would officially be reclassified as *escorteurs d'escadre* (EE) in January 1955, prior to the completion of the first ship.

Hull & Superstructures

The hull was of welded 6–12mm steel, increasing in thickness to 24mm on either side of the keel; it was prefabricated in 84 panels and had a total weight of 1,100 tonnes. There were sixteen watertight transverse bulkheads dividing the ship into seventeen compart-



Chevalier Paul at Cherbourg in 1957, shortly after her entry into service. The French DRBV 20A air surveillance and DRBV 11 combined air/surface search radars are particularly prominent in this bow view. (Leo van Ginderen collection)



Surcouf: Profile and Plan
© John Jordan 2019

Characteristics

Displacement:	3,278 tonnes trial 3,710 tonnes full load
Dimensions:	
Length	123.50m pp; 128.62m oa
Beam	12.71m wl
Draught	4.33m aft, 3.51m fwd
Propulsion:	
Boilers	4 Indret boilers
Engines	2-shaft Parsons geared turbines
Horsepower	63,000CV
Speed	34 knots (designed)
Endurance	5,000nm at 18 knots

Armament:	
Main guns	6 – 127/54 Mle 1948 (3 x II)
AA guns	6 – 57/60 Mle 1951 (3 x II) 4 – 20/70 Mk IV
Torpedo tubes	6 – 550mm AT 47 TT (2 x III) 6 – 550mm KT 50 TT (2 x III) (18 torpedoes)
Electronics:	
Air search	DRBV 20A
Surface search	DRBV 11
Fire control	DRBC 11 (127mm) DRBC 30 (57mm)
Sonar	DUBV 1B, DUBA 1B
Complement:	347

Building Data

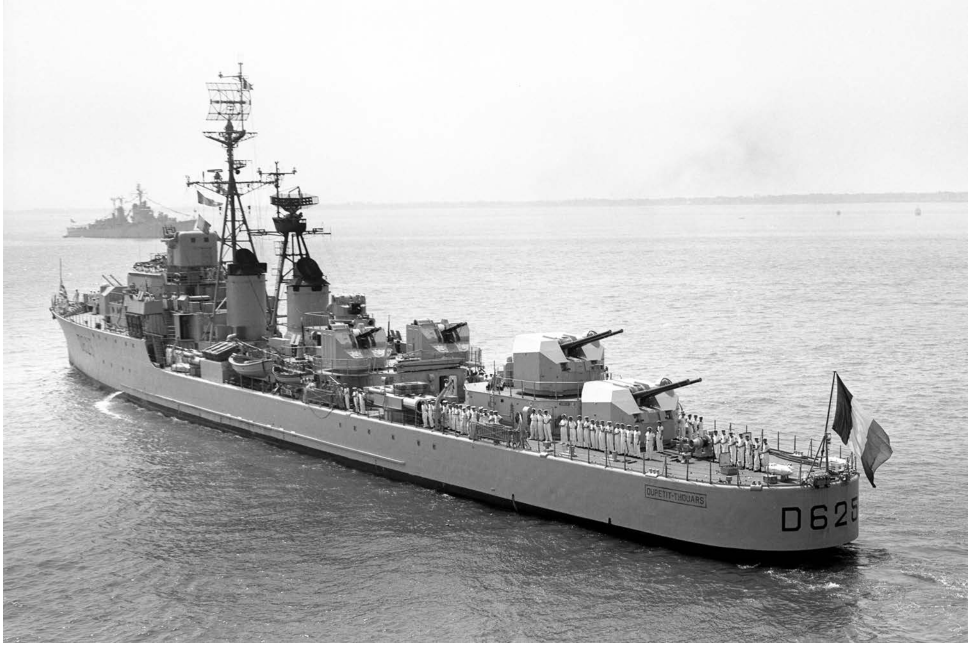
Hull No	Name	Builder	Laid down	Launched	In service
D 621	*Surcouf*	Arsenal de Lorient	16 Jul 1951	3 Oct 1953	1 Nov 1955
D 622	*Kersaint*	Arsenal de Lorient	5 Nov 1951	3 Oct 1953	20 Mar 1956
D 623	*Cassard*	A C Bretagne	3 Mar 1952	12 May 1953	14 Apr 1956
D 624	*Bouvet*	Arsenal de Lorient	16 Jun 1952	25 Sep 1954	13 May 1956
D 625	*Dupetit-Thouars*	Arsenal de Brest	24 Mar 1952	4 Feb 1954	15 Sep 1956
D 626	*Chevalier Paul*	F C Gironde	Feb 1952	28 Jul 1953	22 Dec 1956
D 627	*Maillé-Brézé*	Arsenal de Lorient	9 Oct 1953	2 Jul 1955	4 May 1957
D 628	*Vauquelin*	Arsenal de Lorient	8 Mar 1954	2 Jul 1955	3 Nov 1956
D 629	*D'Estrées*	Arsenal de Brest	6 Oct 1953	27 Nov 1954	19 Mar 1957
D 630	*Du Chayla*	Arsenal de Brest	6 Oct 1953	27 Nov 1954	4 Jun 1957
D 631	*Casabianca*	F C Gironde	23 Dec 1953	13 Nov 1954	4 May 1957
D 632	*Guépratte*	A C Bretagne	19 Oct 1953	8 Nov 1954	6 Jun 1957

ments; for damage control purposes the forward compartments were designated A-G, the midship compartments (housing the propulsion machinery) H-K, and the after compartments L-Q. There was a continuous main (upper) deck of 6–18mm steel and the superstructures were of light alloy (AG 5). The hull form was broadened aft to avoid the need for propeller guards. In service the ships were considered to be good sea-boats, although later increases in topweight resulted in a more pronounced roll; the hull was rated robust, but the bow and superstructures were prone to damage in heavy seas.

In a departure from custom and practice, the officer accommodation was relocated from the after part of the ship to the lower level of the bridge structure, with the accommodation for ratings and petty officers distributed between the main deck forward and the lower deck (*pont des logements*) fore and aft. This placed the officers close to their combat stations. However, separate galleys were retained for officers, petty officers and seamen, and the seamen and the junior petty officers still ate and slung hammocks in broad mess spaces fitted with tables and benches.

Propulsion Machinery

The propulsion machinery was arranged as two completely independent units: Boiler Room 'H' supplied the steam for the turbines in Engine Room 'I', which drove the starboard shaft; Boiler Room 'J' supplied the steam for the turbines in Engine Room 'K' driving the port shaft. Both sets of turbines could be supplied with steam with only one boiler lit. Seven of the twelve ships of the T 47 type had Parsons turbines, the remaining five had turbines designed and manufactured by Rateau. The four-bladed propellers were of high-resistance (HR) bronze. Each unit could deliver 31,500cv at 316rpm. Maximum designed speed was 34 knots (38–39 knots was generally attained on trials). The economical speed was 18 knots with 145rpm; fuel capacity was 750 tonnes of oil, giving an endurance of 5,000nm.



Dupetit-Thouars in June 1957, with the US destroyer leader *Norfolk* (DL-1) in the background. Note the layout of the after guns and torpedo tubes; the after tubes were for long, anti-ship torpedoes, the forward tubes for the K2 anti-submarine torpedo, a straight-running high-speed model, launched in salvos of three. The latter was in service from 1956 until 1979 and was superseded from the early 1960s by the more advanced L3 torpedo, which had acoustic homing. (Leo van Ginderen collection)

127mm/54 Mle 1948 CAD

The 127/54 Mle 1948 was a semi-automatic dual-purpose gun developed in the immediate postwar period. Calibre was initially the traditional French 130mm but was modified to enable the gun to use standard US Navy 5in ammunition. The gun fired a 32kg shell (OEA Mle 1948), and the 8.5kg propellant charge was in a brass case with an all-up weight of 19kg. The magazines could accommodate 1,140 HE shells, of which 380 were tracer for night firing, plus 80 starshell. Muzzle velocity was 810m/s, and the gun had a theoretical firing cycle of 15rpm. Range against surface targets was 16–18,000m (22,400m maximum)

The pseudo-turret permitted a maximum gun elevation of +80 degrees. The total weight of each mounting was 48 tonnes (rotating mass: 14 tonnes). The turret shield had 10mm walls and a 7mm roof. Manning requirements were similar to the prewar models of gun; there were no fewer than eleven personnel in the firing chamber, plus four ammunition handlers in the magazines. The mounting was not particularly successful, proving heavy and over-complex, and had to undergo early modification.

57mm/60 Mle 1951 CAD

This gun was a scaled-up version of the Bofors 40/60, and was built by the French under licence from 1947. Both the enclosed mounting and the ammunition were developed in France. Elevation was from -8° to +90°, and muzzle velocity 865m/s with the OEA Mle 1950 2.96kg proximity-fuzed shell. The gun had the standard Bofors fan-feed system with 80 ready-use rounds, and the passage of the fixed ammunition from the ready-service box to the breech was entirely automatic; the box below the mounting was reloaded by hand at a rate of 40rpm. A total of 10,800 rounds was embarked. Each of the three mountings was manned by eight men (six in the firing chamber, two below). The range of the weapon against aircraft (flying at up to 300m/s) was 3,500m in theory, although in practice it was closer to 3,000m, and the theoretical firing cycle was 50rpm per barrel. The French-designed pseudo-turret provided protection from splinters and from the elements for the gun-crew, and facilitated maintenance: the shield was 7mm with a 10mm face, and the total weight of the mounting was 16 tonnes.

550mm AT 47 torpedo tubes

The two triple 'long' torpedo tubes, which were mounted on the main deck aft, were developed from the prewar models and fired the standard prewar French anti-surface torpedo, Mle 1923DT.

550mm KT 50 torpedo tubes

The two triple 'short' torpedo tube mountings were designed to fire the new K2 'heavyweight' anti-submarine torpedo, which was trialled on the torpedo boat *Lorrain* (ex-Ger *T-28*) and entered service in 1956. Often referred to in the French Navy as a *grenade propulsé* ('self-propelled depth charge'), this straight-running torpedo was launched in salvos of three towards a submarine contact with preset depth fuzing. It had limited range (1,000m) and no homing capability; maximum depth was 300m. The torpedo weighed 1,104kg, including its 280kg warhead, and had oxygen-alcohol propulsion for a speed of 50 knots. Reload lockers behind the two mountings housed six reloads. The K2 was in effect the counterpart to the Royal Navy's Limbo mortar and the US Weapon Alfa. The tubes were trained and fired using remote power control from the ASW Centre, which was forward of the main Operations Room in the bridge structure.

Radars

The DRBV 20A metric air surveillance radar operated in the 'A' Band and had a distinctive square mattress antenna, which in the T 47 was mounted atop the tripod foremast. Maximum range is reported to have been 250km against an aerial target flying at 6000m. The DRBV 11, which had a conventional parabolic antenna with a prominent feed and was mounted atop the shorter mainmast, was a combined air/surface surveillance radar. It had a superior performance against low-altitude targets, but detection range was only 60–120km. The DRBV 30 was a short-range navigation radar capable of detecting and tracking surface ships up to 40km.

There were separate fire control radars for the 127mm and 57mm guns. The DRBC 11 was an 'S'-Band radar for surface gunfire out to 50km; its antenna was mounted on the left side of the main gunnery director, which was also fitted with an OPL 6-metre stereo rangefinder. The DRBC 30 was an 'X'-Band radar for AA fire control with a range of 35km; the single director was mounted on the centreline abaft the second funnel. There were optical sights fore and aft for back-up.

Sonars

The T 47 class had a DUBV 1 sonar in a retractable dome which could be lowered through the underside of the hull between Frames 86 and 88. DUBV 1 was a high-frequency surveillance sonar derived from the British Asdic 128 models transferred to France in 1940 – on the plans the compartment is labelled *Appareil Asdic*; maximum range was 3,200m and the sonar was usable up to 24 knots, at which point self-noise obliterated the signal. Its companion was the DUBA 1 HF attack sonar, a searchlight model intended to provide guidance for the K2 torpedoes; practical range was 2500m (3200m max), well beyond that of the torpedo.

Sources:

Official plans of *Surcouf* held by the Centre d'Archives de l'Armement.

Robert Dumas & Jean Moulin, *Escorteurs d'Escadre*, Marines Editions (Rennes, 2012).

WARSHIP NOTES

This section comprises a number of short articles and notes, generally highlighting little known aspects of warship history.

THE 6in TURRETS OF *NELSON* AND *RODNEY*

John Jordan looks at the Mark XVIII twin mounting which equipped the two battleships of the *Nelson* class.

At the end of the First World War, the standard Royal Navy anti-destroyer gun was the 6in Mark XII BL. Its 100lb projectile was deemed to be the heaviest which could be handled by the average seaman, and it was capable of stopping a hostile destroyer or torpedo boat before it could launch torpedoes. The 6in gun was hand-worked, and was mounted on a light pedestal (P) or centre pivot (CP); in battleships it was in an armoured casemate battery, in cruisers in open shielded mounts.

At Jutland the light cruisers *Chester* and *Southampton*, which had their 5.5in/6in guns in open mountings, suffered heavy casualties from splinters among their gun crews, while the guns themselves remained virtually undamaged. *Malaya* likewise suffered heavy losses among the gun crews of her starboard battery when an enemy heavy shell penetrated the 1in armour of the deck above her casemate guns. It was also found that the gun crew of the forecastle mounting in the latest light cruisers was badly affected by spray when the ship was firing on the broadside at high speed. This led to the development of an enclosed 'weatherproof' mounting intended for the 'C', 'D' and 'E' classes, the Mark XVI; a prototype was installed in the light cruiser *Diomede* on her completion in 1922 (see the photo in *Warship 2018*, page 171).

A further negative characteristic of the open pivot mounting was the limited elevation possible, which in turn limited the range at which enemy vessels could be engaged. The PIX casemate mounting in the battleships had a maximum elevation of only 14 degrees, while the open upper deck mountings in the cruisers could elevate to a maximum of 30 degrees. For the enclosed Mark XVI mounting it proved possible to raise maximum elevation to 40 degrees, for a theoretical range of 20,600 yards.

When these issues were deliberated in the immediate postwar era by the Fire Control Requirements and Post-War Questions Committees (see Friedman, *op cit*), it was recommended that a new enclosed twin 6in mounting be developed to constitute the main armament of cruisers and the secondary armament of future battleships and battlecruisers. In addition to meeting the concerns outlined above, the twin enclosed mounting would have the following advantages:

- It was more economical in terms of deck space and hull volume, which was limited in cruisers by the need for speed; the main guns could be mounted fore and aft with the magazines directly beneath, thereby freeing up the centre section of the hull for propulsion machinery.
- It facilitated director control – earlier single guns on pivot mountings had been designed for individual gunlaying.
- In battleships, the splinter-proof shield was resistant to the blast when the big guns were fired, making it easier to find suitable positions for the mountings above the weather deck.

There would inevitably be a cost in weight. An enclosed twin mounting with high angles of elevation needed power for training and for ammunition supply to the gunhouse. However, the weight of the electro-hydraulic motors could counterbalance the weight of the loading numbers and the rear overhang of gunhouse, which was needed to provide the necessary working space. It would also be possible to provide splinter protection for the gunhouse in an enclosed mounting, although the 6in Krupp armour which protected the batteries of the most recent battleships was out of the question.

A prototype twin enclosed mounting, Mark XVII, was tested in the cruiser *Enterprise* following her completion in January 1926. It employed a 40hp electric motor powering a hydraulic pump for training and ammunition supply, and was capable of a similar elevation to the single Mark XVI mount in *Diomede*: 40 degrees. *Enterprise* also trialled the new Director Control Tower (DCT).

The Mk XVIII mounting

The Mark XVIII mounting devised for the battleships *Nelson* and *Rodney* was a development of the Mark XVII. It employed a new gun of more modern construction, the Mark XXII – the older Mark XII had been retained for *Enterprise* so that it matched the performance of the guns in the single mountings – but was similar in conception, and the gunhouse had the same basic layout. However, there was a major difference in ammunition supply arrangements: whereas the twin mounting in the cruiser was located on the ship's axis and was supplied directly by hoists from the associated magazine and shell room beneath, the mountings in the battleships were at the sides of the ship and the shell rooms and magazines on the middle line.

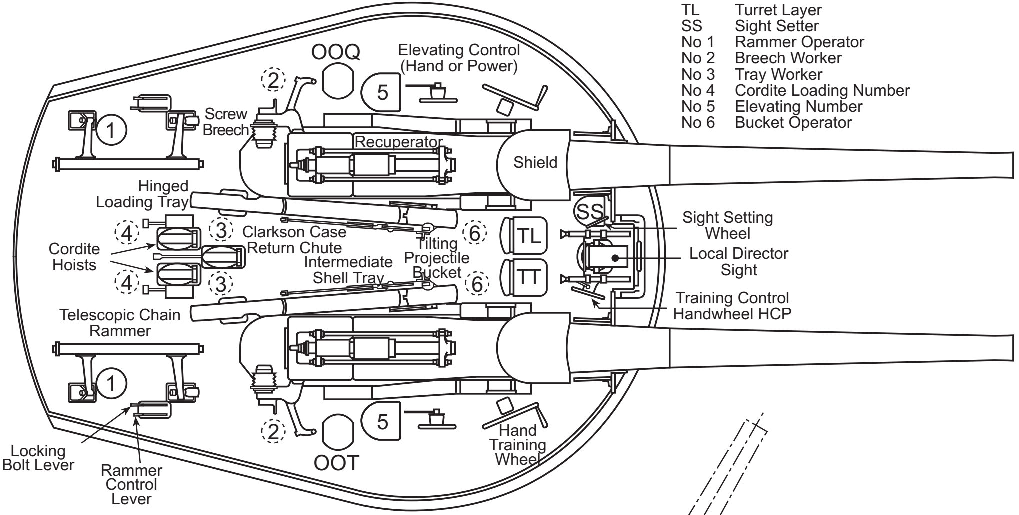
There was considerable enthusiasm in the Navy for using heavy HA guns to put up a barrage, using time-fuzed ammunition, with a view to breaking up close formations of enemy bombers so that the fleet's fighters could pick off individual aircraft. At a meeting chaired by

Nelson & *Rodney:* 6-inch Mk XVIII Turret

Plan View of Gunhouse

Key to Personnel

OOT	Officer of Turret
OOQ	Officer of Quarters
TT	Turret Trainer
TL	Turret Layer
SS	Sight Setter
No 1	Rammer Operator
No 2	Breech Worker
No 3	Tray Worker
No 4	Cordite Loading Number
No 5	Elevating Number
No 6	Bucket Operator


OOQ
Elevating Control (Hand or Power)
2
5
1
Screw Breech
Recuperator
Shield
Hinged Loading Tray
SS
Sight Setting Wheel
4
3
Clarkson Case Return Chute
Tilting Projectile Bucket
6
TL
Cordite Hoists
Intermediate Shell Tray
TT
Local Director Sight
Training Control Handwheel HCP
Telescopic Chain Rammer
1
5
2
Locking Bolt Lever
Rammer Control Lever
OOT
Hand Training Wheel

Note: Based on official General Arrangement plans.

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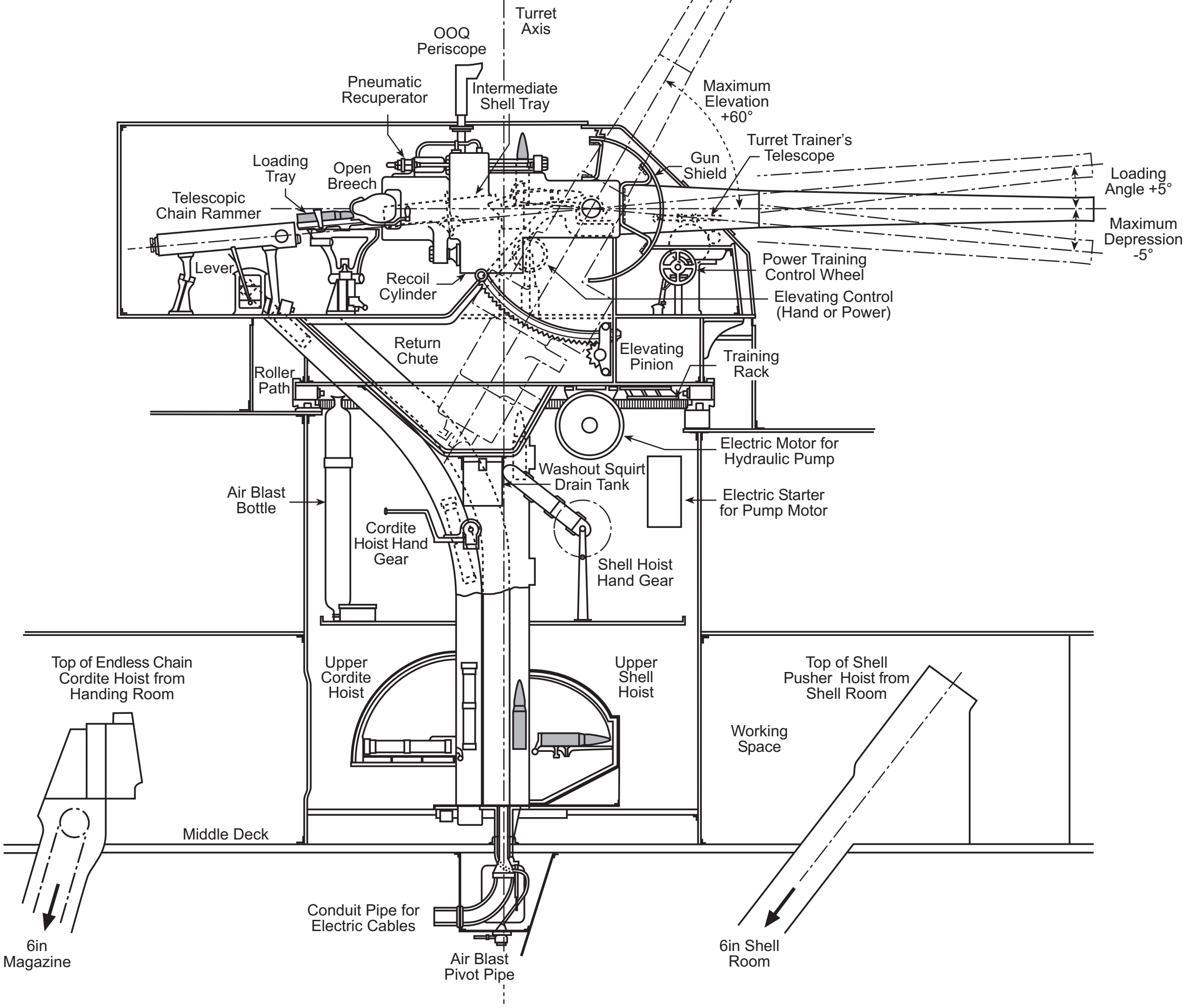
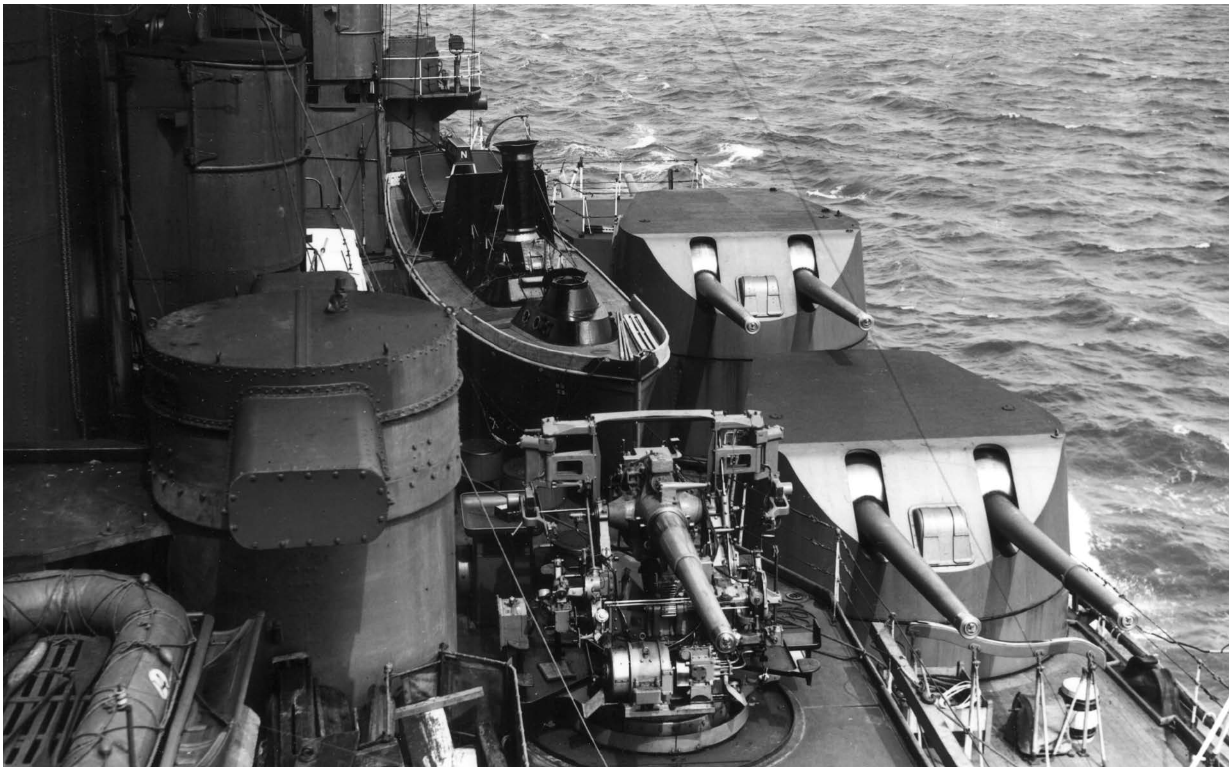
Longitudinal Section of Turret


Turret Axis
OOQ Periscope
Pneumatic Recuperator
Intermediate Shell Tray
Maximum Elevation +60°
Turret Trainer's Telescope
Loading Tray
Open Breech
Gun Shield
Loading Angle +5°
Telescopic Chain Rammer
Maximum Depression -5°
Lever
Recoil Cylinder
Power Training Control Wheel
Elevating Control (Hand or Power)
Return Chute
Elevating Pinion
Training Rack
Roller Path
Electric Motor for Hydraulic Pump
Washout Squirt Drain Tank
Air Blast Bottle
Electric Starter for Pump Motor
Cordite Hoist Hand Gear
Shell Hoist Hand Gear
Top of Endless Chain Cordite Hoist from Handing Room
Upper Cordite Hoist
Upper Shell Hoist
Top of Shell Pusher Hoist from Shell Room
Working Space
Middle Deck
Conduit Pipe for Electric Cables
6in Magazine
Air Blast Pivot Pipe
6in Shell Room



Two of the port-side 6in turrets of HMS *Nelson*. Note the projecting housing for the Local Director Sight at the front of the turret, and the small circular plates at the front end of the turret roof over the alternative positions for the OOQ's periscope. (Wright & Logan)

the Controller on 4 October 1922 it was stated that an increase in the elevation of the mounts to 55 degrees would cost little in terms of weight. The angle of maximum elevation would later be further increased to 60 degrees; the angle of maximum depression was 5 degrees, as in the Mk XVII prototype.

The Mark XVIII mounting used a 50hp electric motor powering a hydraulic pump using oil, mounted on the revolving structure. The guns were in individual steel cast cradles with compressed-air run-out, and there was a deep gun well to facilitate the high angle of elevation. For training there was a single engine with rack and pinion drive with manual back-up. Elevation was by a swash-plate engine driving, through worm and pinions, an arc attached to the cradle; alternatively hand gear could be used.

Data Table

6in Mark XXII Gun	
Weight incl BM	9.0125 tons
Total length	309.73in
Length in calibres	50 cal
Chamber length	40.81in
Chamber volume	1,750in^3
Projectile weight	100lb
Propellant charge	31lb SC 150
Working pressure	20.5 tons/in^2
Muzzle velocity	2,960ft/s
Maximum range	25,800yd at 45°
Mark XVIII Mounting	
Revolving weight	85 tons
Roller path diameter	14ft mean
Distance apart gun axes	78in
Recoil distance	16.5in
Turret Shield	1½–1in
Elevation/depression	+60° / –5°
Firing cycle	5rpm (12 secs)

Souce: John Campbell, *Naval Weapons of World War Two*, Conway (London 1985).

Ammunition supply

Unlike the turrets for the large-calibre guns, the Mark XVIII mounting employed split hoists, with fixed lower hoists from the magazines and shell rooms, and upper hoists that were suspended from the turntable and revolved with the gunhouse. This was a simple, lightweight solution which took advantage of the comparative ease with which the 100lb shells and 30lb cordite charges could be transferred by hand in the intervening working space.

In *Nelson* and *Rodney* there was a lower magazine with a single handing room and two hoists to supply the working spaces for the forward pair of mountings (S1 and P1). The upper magazine had two handing rooms and four hoists to supply the working spaces for the centre and after mountings (S2/3 and P2/3). The shell room above was equipped with six hoists (one per mount). The cordite hoist was of the endless chain type with a pusher hoist for the projectiles; both were electrically powered. The hoists were angled outward from the magazines and shell rooms to the working spaces on the middle deck, and even from this point the ammunition had to be moved farther outboard to the hoists in the mountings. The two upper hoists (one for projectiles, the other for the cordite propellant charges) were both of the hydraulic pusher type, and revolved with the turret. They were loaded by hand from the working space.

In the gunhouse the shell hoists emerged close to the turret axis in rear of the cradle trunnions; the cordite hoists emerged close to the centreline, behind the breeches of the guns. The shells were transferred via a tilting bucket and an ‘intermediate’ tray to the loading tray, which pivoted on an arm from the cradle, then rammed at a fixed angle of 5 degrees using a telescopic chain rammer (see accompanying illustration). The cordite charges were lifted from the upper hoists by the two loading numbers, placed on the loading tray and hand loaded.

The cordite charges, which were in silk bags to ensure complete combustion in the firing chamber of the gun, were stowed in the magazine in rectangular cases each holding five charges. They were removed from the cases in the magazine and each individual charge was then loaded into a flash-proof Clarkson case, which was made of leather and lined with cork. A total of 248 Clarkson cases were stowed in the magazines – presumably on the basis of 20 per gun plus eight spare. The charges were then passed via revolving vertical flash-tight scuttles into the handing rooms, where they were placed in the fixed, electrically-driven hoists. On arrival in the working space they were passed through a further set of flash-tight scuttles to the upper hoists and raised to the gunhouse, where the bagged cordite charge was extracted immediately prior to loading. The cases were not expendable, so were returned to the working space via a tube, and thence to

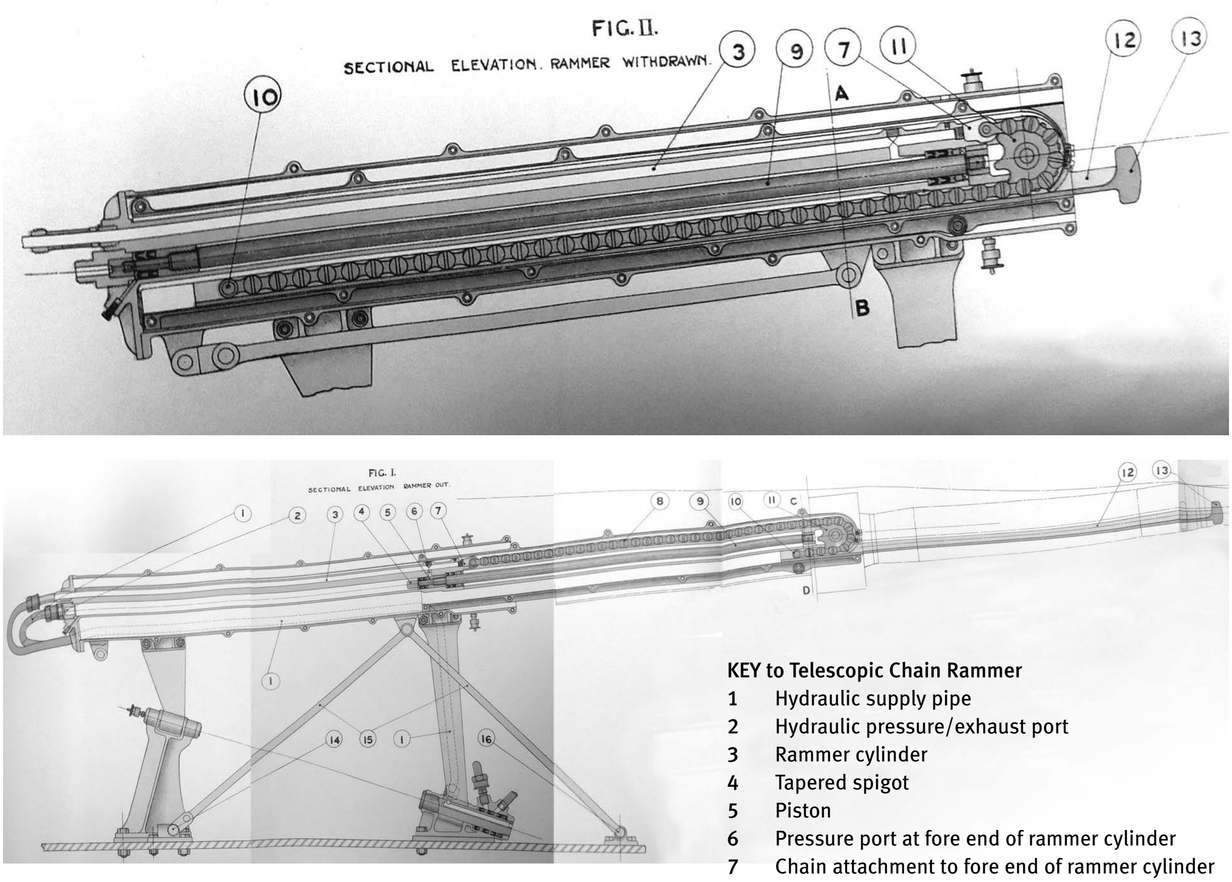


FIG. II.
SECTIONAL ELEVATION. RAMMER WITHDRAWN.
3
9
7
11
12
13
10
A
B
FIG. I.
SECTIONAL ELEVATION RAMMER OUT.
1
2
3
4
5
6
7
8
9
10
11
C
12
13
D
1
14
15
1
16

KEY to Telescopic Chain Rammer

1	Hydraulic supply pipe
2	Hydraulic pressure/exhaust port
3	Rammer cylinder
4	Tapered spigot
5	Piston
6	Pressure port at fore end of rammer cylinder
7	Chain attachment to fore end of rammer cylinder
8	Chain
9	Piston rod
10	Chain fixed at rear end of stave
11	Sprocket wheel
12	Rammer stave
13	Rammer head
14	Fixing pin for portable stay
15	Portable stays
16	Fixing pin for portable stay

The telescopic chain rammer in its ‘withdrawn’ and ‘extended’ positions. The original plan of the rammer in the extended position was folded and the photos had to be stitched together, which has resulted in some distortion. The rammer was fixed to the deck, so loading had to be carried out at a fixed angle of +5 degrees. If the rammer failed, the portable support stays could be disconnected from the floor by removing the fixing pins so the whole rammer assembly could by hinged to the side to allow hand loading. (Images and key courtesy of John Roberts) the magazine using the 'down' side of the lower cordite hoist. This would be the last time Clarkson cases were used in a 6in mounting; the cruiser mountings which followed (Mark XXI twin, Marks XXII and XXIII triples) would use disposable cardboard containers for their cordite charges.

Fire control and manning

For low-angle (LA) fire, *Nelson* and *Rodney* were fitted with four of the new Director Control Towers. The DCTs, each of which was equipped with a 12ft rangefinder, were paired atop the tower and aft on either side of the main DCTs for the 16in guns, and served as an integrated control and calculating position; each could control a group of three turrets or, alternatively, one/two turrets if more than one target was being engaged on the same side of the ship.

In **Director Control**, the angle of train was transmitted directly via a follow-the-pointer (FTP) receiver to the turret trainer (TT), who had a hand wheel that controlled the training engine, and the angle of elevation to the elevating positions outside the guns. In this mode the guns were fired by the director layer.

For other modes of control the turret was fitted with a Local Director Sight (LDS), which was located at the front end of the gunhouse between the guns. The positions for the turret trainer (TT) and layer (TL) were both equipped with telescopic sights, and the sight setter (SS) was tasked with entering deflection and range, either from the FTP receivers or following the orders of the Officer of Quarters (OOQ). Possible control modes were:

- **Gunlayers**: angle of train transmitted from the DCT, elevation angle from the LDS to the elevation FTP receivers; guns fired by the LDS layer.
- **Quarters**: as Gunlayers but angle of train from LDS.
- **Local**: The OOQ, who could control one or more turrets, ordered the range and deflection settings.

The two forward 6in DCTs also served as high-angle (HA) control positions, transmitting via HACS tables; the after DCTs were LA only.

There were seats on the right and left of the gunhouse for the OOQ and for the officer of turret (OOT). Either position could be fitted with a periscope for the OOQ, the seat opposite being used by the OOT, who supervised all operations in the gunhouse; both positions were equipped with a changeover switch between the director and the LDS for the firing circuit. If the director was out of action it might still have been possible for the OOQ to communicate with the DCT (or some other control position) for spotting and/or rangefinder information; otherwise he would have to rely on his own observation from the periscope.

The other personnel stationed in the gunhouse were: two rammer operators (1), two breech workers (2), two loading tray workers (3), two cordite loading numbers (4), two elevating numbers (5), and two operators for the tilting buckets that tipped the 6in shells over on arrival at the top of the hoist (6), the shells being shunted manually onto the inclined waiting ('intermediate') tray.

Acknowledgement :

I am particularly grateful to John Roberts for photographing the original plans of the turret, for supplying the images and key for the telescopic chain rammer, and also for his infinite patience in answering my questions about Clarkson cases and fire control arrangements in these ships.

Sources:

John Campbell, *Naval Weapons of World War Two*, Conway Maritime Press (London 1985).

Norman Friedman, *British Cruisers*, Seaforth Publishing (Barnsley 2010).

THE MOBILE NAVAL BASE

David Murfin looks at the proposals for Mobile Naval Bases for overseas deployment by the Royal Navy put forward after the Great War.

The end of the Great War brought new problems for the Royal Navy. Britain might need to maintain a larger peacetime fleet if Germany's warships interned in Scapa Flow were shared among the allies as planned. When the Germans ships were scuttled, their jailer may have looked somewhat foolish, but perhaps felt some relief.

Britain's recent chief allies at sea, the USA and Japan, had been far enough from any major naval battle with Germany to be able to pursue both the construction of new capital ships and the development of new designs. Most American designs featured their 'all or nothing' armour scheme, while growing rivalry with Japan meant that both were planning battleships of over 40,000 tons. HMS *Hood*, building for the Royal Navy as redesigned after the battle of Jutland, was of similar size but had a conventional – albeit enhanced – protection scheme. Building three planned sister ships was of doubtful value. The rivalry between the USA and Japan shifted the strategic focus to the Pacific. The 1905 Anglo-Japanese Alliance had allowed the RN to withdraw battleships from its China Station, leaving only a cruiser force there. During the war, with protecting the Atlantic shipping lanes vital, the US Navy co-operated closely with the RN, providing the Sixth Battle Squadron, but Japan had declined to lend her battlecruisers. With the war against Germany over, Japan sought to extend her influence in the Pacific. Britain had to look again at the resources needed to defend her extensive imperial interests in Australia, New Zealand, Malaya and India.

The RN fleet's fitness for worldwide service relied on Britain's widespread chain of naval bases, with Hong Kong, Singapore and Colombo in Ceylon now the most relevant. Her recent ships, light cruisers especially, were designed primarily for the war with Germany, and did not have the range easily to reach and fight in the Pacific. They needed support for their passage from the Mediterranean to Singapore (when that base was ready) and to provide base facilities across the East if it was not. Could the base travel with the fleet? Might combined operations with a strong force of marines also be supported? Serious planning for this new strategy began in 1920, focusing initially on the overall concept rather than particular ships. The Admiralty Local Defence Division (LLD), set up in 1919 to assess the defence capabilities of naval bases and commercial ports, evaluated RN needs in any war with Japan or USA or in Europe.[1] The Assistant Chief of Naval Staff (ACNS) and the heads of other branches of the Navy involved supported its report.

Bases

A war with Japan assumed an established and adequately defended base at Hong Kong, but work was to be pressed ahead to make Singapore the principal base in the Far East. An advance base nearer to Japan, at Chusan, might be needed, plus protected anchorages at Suez or Diego Garcia for fuelling the fleet on its way to the Far East. War with the USA would need a home base on the west coast of Ireland and others at Halifax and in the Bermudas. Bases in Britain and Malta would suffice for another European war, but others might be needed to fuel the main fleet elsewhere, or for destroyers and submarines. New permanent bases might prove unnecessary, possibly provocative, certainly expensive.

Mobile Naval Bases (MNB) were the LLD's answer. These were not ships, but assemblages of men and materiel at main bases, ready to be taken to support the fleet elsewhere by rapidly establishing a temporary base on shore where required, adequately defended against attack from the sea or overland. Specialist reservists would set up repair facilities, wireless communications and defences manned by Royal Marines. All these would be transported to the chosen site by a specialised MNB Depot Ship, fast enough to accompany the fleet. Once there, the intention was to establish a force on shore within 48 hours, with temporary gun and searchlight defences, plus temporary net defences for the ships involved, and within a week make it moderately safe from attack by submarines or destroyers, or from the air. Within a month booms and minefields should be in place with gun and other defences complete. The base should provide a safe anchorage and fuelling station for a fleet, be self-contained with regard to its own maintenance and equipment, but retain its mobility to be taken elsewhere. The Navy, in particular the Royal Marine Corps, would be responsible for its initial defence, which would depend on its size and geography, the scope of operations to be supported, the strength of naval forces involved, and the likely scale of any attack. It was not expected to withstand a full-scale invasion or bombardment by heavy guns from sea or land. Typically a mobile base would have two entrances each perhaps a mile wide. It would need manpower to run it, to organise a supply chain from the nearest main base, and establish six specialised 'units' each providing one form of initial defence:

- shore defences: gun batteries (6in or smaller plus AA), searchlights, smoke projectors
- a full-strength company of Royal Marines (their smallest self-contained unit) providing the infantry garrison and military policing for the base and any civilian population
- mobile defences afloat: patrol craft, minesweepers, allowing for refits, fuelling and rest
- underwater defences: boom defence, submarine cables and mines
- aerial defences and patrols from the smallest RAF self-contained unit
- maintenance, internal organisation, signals and communications to cope with one light cruiser squadron and one flotilla of destroyers, to be expanded if capital ships were involved.

Such fighting ships would use the base without involvement in establishing, operating or defending it. If the base were then developed to provide further non-fuel supplies and repair services, needing further equipment and additional specialist personnel, the military authorities would take over its more permanent defence.

The key to the MNB concept was the MNB depot ship kept ready at its home base. That ship would not simply transport equipment and personnel to the required site. It would then provide an administrative centre, a large distilling plant to meet the water needs of the base and high-power wireless communications afloat (keeping the base mobile by avoiding permanent buildings ashore). In the early stages it would also act as depot ship for numerous boats and small craft with harbour duties. Other specialist ships would include a boom defence vessel, minesweeping trawlers, a small minelayer (doubling as a cable laying ship), and small craft for harbour defence and general ship-to-shore duties.

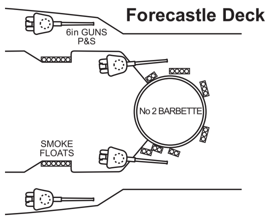
The scheme was opportune because war surplus stocks could provide much of the equipment and weaponry to be kept ready, but unused unless war came. A purpose-designed depot ship was preferable, but an obsolescent early dreadnought on the disposal list might provide the necessarily large depot ship, able to help defend the base (perhaps recalling the successful 'first strike' against von Spee's cruiser squadron from the guns of the old *Canopus*, moored in Port Stanley in the Falklands, or the wartime use of big gun monitors as harbour guardships in the Dardanelles and at Dover).

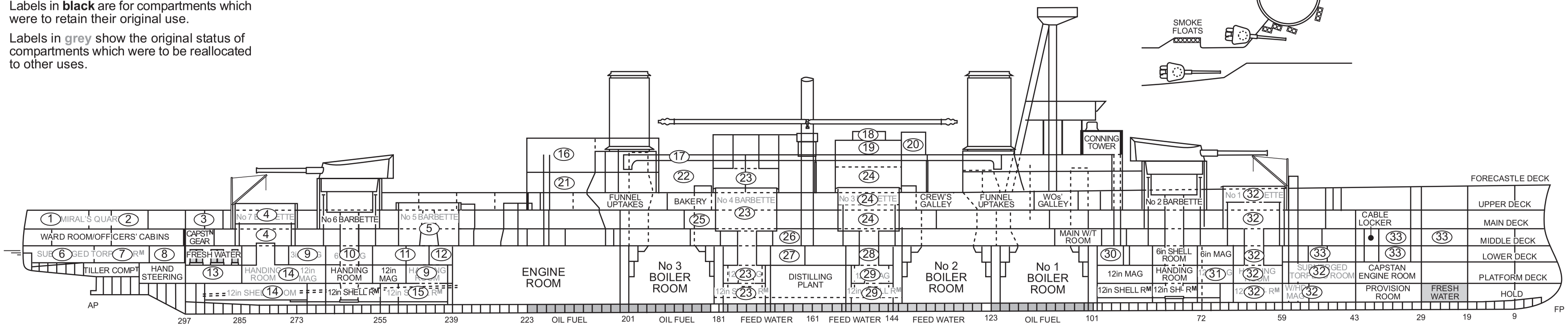
The large hull of HMS *Agincourt* seemed particularly suitable. Most of her seven 12in gun turrets could be removed, along with her secondary armament, and still leave some big guns for defence. The weight saved would allow other stores and base facilities such as workshops and offices to be added. The two superfiring turrets with higher command were retained. Their barbettes were less accessible for other uses. The remaining armoured barbettes and magazines offered safe stowage for mines and ammunition for other ships or base defences. Her speed was sufficient to keep up with the main fleet. Those are reasoned considerations, but the records are silent on

Proposal for HMS *Agincourt* as a MNB Depot Ship

Note:
Labels in **black** are for compartments which were to retain their original use.

Labels in grey show the original status of compartments which were to be reallocated to other uses.


Forecastle Deck
6in GUNS P&S
No 2 BARBETTE
SMOKE FLOATS

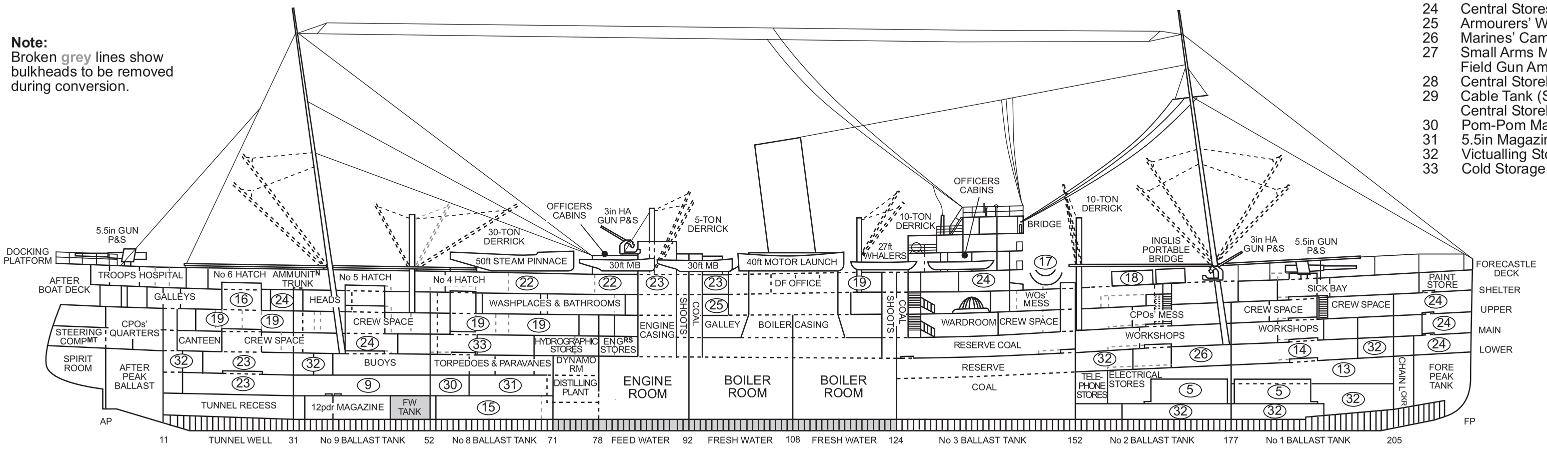

FORECASTLE DECK
UPPER DECK
MAIN DECK
MIDDLE DECK
LOWER DECK
PLATFORM DECK
HOLD
AP
FP
CONNING TOWER
FUNNEL UPTAKES
BAKERY
No 4 BARBETTE
CREW'S GALLEY
WOs' GALLEY
No 2 BARBETTE
No 1 BARBETTE
CABLE LOCKER
WARD ROOM/OFFICERS' CABINS
CAPSTN GEAR
FRESH WATER
TILLER COMPT
HAND STEERING
No 7 BARBETTE
No 6 BARBETTE
No 5 BARBETTE
HANDING ROOM
12in MAG
12in SHELL RM
ENGINE ROOM
No 3 BOILER ROOM
DISTILLING PLANT
No 2 BOILER ROOM
No 1 BOILER ROOM
MAIN W/T ROOM
6in SHELL ROOM
6in MAG
CAPSTAN ENGINE ROOM
PROVISION ROOM
FRESH WATER
OIL FUEL
FEED WATER
297
285
273
255
239
223
201
181
161
144
123
101
72
59
43
29
19
9

Key:

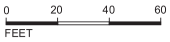
1 Commanding Officer's Cabin
2 Emergency Sleeping Quarters for 10 Officers
3 Offices
4 Mining Workshop
5 Cable Tank
6 Torpedo Workshop
7 Torpedo Head Magazine (Stbd)
Wet Guncotton Magazine/DC Stowage (Port)
8 Depth Charge Stowage
9 3in HA Magazine
10 Paymaster's Store
11 Electricians' & W/T Workshop
12 W/T Store
13 Minelaying & Minesweeping Gear
14 Stowage for Mines
15 5.5in Shell Room
16 Engine Smiths' & Boilermakers' Shop (Stbd)
Foundry & Coppersmiths' Shop (Port)
17 Boat Deck
18 Pontoon
19 Pier Material
20 W/T Office
21 Garage Workshop
22 Garage
23 Guns & Mountings
24 Central Stores
25 Armourers' Workshop
26 Marines' Camp Equipment
27 Small Arms Magazine (Stbd)
Field Gun Ammunition (Port)
28 Central Storekeeping Compartment
29 Cable Tank (Stbd)
Central Storekeeping Compartment (Port)
30 Pom-Pom Magazine
31 5.5in Magazine
32 Victualling Stores
33 Cold Storage

Proposal for *Oropesa* as MNB Depot Ship

Note:
Broken grey lines show bulkheads to be removed during conversion.


DOCKING PLATFORM
5.5in GUN P&S
AFTER BOAT DECK
TROOPS HOSPITAL
GALLEYS
STEERING COMPMT
CPOs' QUARTERS
SPIRIT ROOM
AFTER PEAK BALLAST
CANTEEN
CREW SPACE
No 6 HATCH
AMMUNITN TRUNK
HEADS
No 5 HATCH
BUOYS
TUNNEL RECESS
12pdr MAGAZINE
FW TANK
30-TON DERRICK
No 4 HATCH
50ft STEAM PINNACE
WASHPLACES & BATHROOMS
TORPEDOES & PARAVANES
HYDROGRAPHIC STORES
ENGRS STORES
DYNAMO RM
DISTILLING PLANT
OFFICERS CABINS
3in HA GUN P&S
30ft MB
5-TON DERRICK
ENGINE CASING
COAL SHOOTS
GALLEY
ENGINE ROOM
40ft MOTOR LAUNCH
DF OFFICE
BOILER CASING
BOILER ROOM
27ft WHALERS
10-TON DERRICK
OFFICERS CABINS
BRIDGE
WARDROOM
WOs' MESS
CREW SPACE
RESERVE COAL
INGLIS PORTABLE BRIDGE
CPOs' MESS
WORKSHOPS
TELE-PHONE STORES
ELECTRICAL STORES
SICK BAY
PAINT STORE
CHAIN LCKR
FORE PEAK TANK
FORECASTLE DECK
SHELTER
UPPER
MAIN
LOWER
AP
FP
11
TUNNEL WELL
31
No 9 BALLAST TANK
52
No 8 BALLAST TANK
71
78
FEED WATER
92
FRESH WATER
108
124
No 3 BALLAST TANK
152
No 2 BALLAST TANK
177
No 1 BALLAST TANK
205

Drawings adapted from the profile in NMM *Agincourt* rolls 455833 and the *Oropesa* profile in ADM 1/9241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exactly why *Agincourt* was chosen, the report concentrating on how to obtain and train specialist personnel to man the Base Depot Ship and the ancillary small craft. Nevertheless, the ideas were pressed forward enthusiastically, intending to use the 1921 fleet exercises to establish such a base in home waters as a trial and for training.

At this point two other Navy departments contributed. The Director of Naval Intelligence helpfully indicated that progress would be quicker without trying to keep so wide-ranging a project top secret, as proposed. Only the wartime destinations for the bases would need that level of secrecy. However, the Finance Committee required to know what sums for the project would be sought in next year's Estimates and what sale income might be lost by converting ships and appropriating weaponry. That led to some 'units' for land and seaward defence being combined. Early in 1921 a note of subsequent Board decisions stated: 'The Board approved in principle of this organisation as an object to be aimed at and made the following provision in the 1921–22 Estimates: (a) Towards fitting out a base ship – £39,000 (HMS *Agincourt* inked in) (b) Purchase of stores – £36,000.'

The Washington Treaty 1922

Proposal (a) was abandoned – a rarely discussed result of the Washington Treaty; (b) was reduced to £28,000 and confined to the purchase of stores considered necessary for training Royal Marine personnel. Proposal (a) contains the only reference in these reports to *Agincourt's* selection. Initial tight secrecy may be why *Agincourt's* Ship's Cover – shared with *Canada* and *Erin* – contains no information on the considerable design work done on her conversion, evidenced by the detailed plans now in the National Maritime Museum (see the redrawn inboard profile).

That the Washington Treaty took *Agincourt* out of the picture is unsurprising. An MNB depot ship with 12in guns would have taken about 28,000 tons of the Royal Navy's allowed capital ship tonnage, cutting the battle fleet by at least one ship. In fact the Treaty prohibited *Agincourt's* conversion altogether, scheduling *Agincourt* (and earlier dreadnoughts) for scrapping, with Article XIII prohibiting reconversions. No warships over 10,000 tons standard could be acquired in peacetime outside the agreed list of capital ships and carriers, except unarmed troopships or supply ships (Article XI). MNB depot ships, clearly 'vessels of war', would exceed 10,000 tons standard. Apart from stiffening decks for guns up to 6in, Article XIV forbade peacetime installation of warlike armaments to convert merchant vessels to vessels of war, but this was deemed not to apply to ships acquired for the fleet as 'auxiliaries'. A large merchant ship could become a peacetime troopship then act as an MNB depot ship immediately on declaration of war. (To be effective, that slightly specious Washington interpretation[2] would need the ship already converted and near its main base.)

Merchant ship conversions

Using currently available war surplus weaponry outweighed savings from slowing progress or postponing action for five years. On 23 March 1922 the LDD Committee asked the Board to decide between converting merchant ships into permanent base ships or requisitioning ships only when needed. Suitable vessels could certainly be found, though more than one per base might be needed. Other disadvantages were:

- An acquired ship could not be ready with the necessary personnel and equipment without good notice, delaying despatch of the MNB in an emergency.
- With no permanent depot ship, training personnel would be difficult and cost more.
- A permanent ship would have (and an acquired ship lack) detailed stowage plans for efficient discharge of stores at the base, in proper sequence.
- Ships to be acquired would need to be able to lift heavy and bulky items such as guns, mines, antisubmarine devices, huts and lorries; existing ships with the efficient derricks needed to lift 20 tons were uncommon.
- Carrying ammunition would need special ships with cooled magazines.
- Ships having large water distilling capacity would be needed.
- An acquired ship would need workshops and machinery to do repairs.

If the Board decided to acquire ships, all departments should consider the alterations necessary, prepare full inventories of what was to be carried and seek to reduce requirements.

Work went ahead on planning a permanent conversion, postponing financial comparisons between alternative schemes. To promote discussion of general suitability and detailed arrangements, while avoiding possibly unnecessary work on other suggestions, on 23 February 1923 the Director of Naval Construction (Tennyson d'Eyncourt) reported progress. The vessel considered was SS *Oropesa* owned by Pacific Steam Navigation Co, typical of modern intermediate liners generally available and suitable as troopships if taken up in peacetime. Facilities and arrangements for stowage of equipment and ammunition were based on those previously proposed for *Agincourt*, though *Oropesa* was considerably smaller. D'Eyncourt estimated her displacement as an MNB depot ship at 24,000 tons full load (including some ballast if needed), 16,500 tons standard. *Agincourt*'s 28,000 tons standard included heavy guns and armour. Length, beam, and number of decks were: for *Agincourt* 672ft x 89ft (5.5 decks); for *Oropesa* 552ft x 66ft (7 decks including superstructure). Rough estimates from these figures suggest that *Agincourt* had about 30% more deck area. Much of that difference stemmed from her more powerful machinery (34,000shp) and the barbettes, magazines and crew space for the two 12in gun turrets retained. Less powerful machinery (10,600shp) left *Oropesa* some 8 knots slower, able to match only the cruising speed of the fleet, while the big guns were valuable features *Oropesa* lacked. She offered no armour protection for mines nor for munitions carried for defending the base (see drawing). Her proposed defensive armament was only four 5.5in guns and four 3in HA. Defending the base might need fighting ships in support, contrary to initial plans.

Ongoing Cabinet rulings that war was not expected within the next ten years accentuated financial stringency. In March 1926 LDD reported seeking only £10,000 a year to 1933 for minor naval operations in emergencies and support of possible landing operations. The 1926 Estimates included £2,000 for maintenance and experiment, and £7,500 for the first year's instalment of a ten-year programme. But overall Admiralty planning increasingly sought to reduce total expenditure; new limits in proposed naval treaties occupied design teams. The Washington Treaty had dealt the scheme a body blow; tightening purse strings strangled it.

Sources:

ADM 116/2335 Case No 1481 Organisation of Mobile Naval Bases 1920–28.

ADM1/9241 A substitute for *Agincourt* as MNB depot ship 1922.

Author's note: These documents contain reports on the plans and problems with much more detail than space here permits. Grateful thanks to John Jordan for preparing the unusually difficult diagram comparing *Agincourt* and *Oropesa*.

AN UNPUBLISHED ACCOUNT OF THE LOSS OF HMS *VICTORIA*

Warship reader and occasional contributor **Kenneth Fraser** here presents a previously unpublished eye-witness account of the loss of HMS *Victoria* in 1893.

Among the papers of the ancient Scottish family of Anstruther of Balcaskie, held at St Andrews University Library, is a hitherto unknown eye-witness account of the loss of HMS *Victoria*, in a letter from Lieutenant Robert Hamilton Anstruther to his sister Mary Evelyn. I am indebted to Maia Sheridan of St Andrews University Library Special Collections for drawing this letter to my attention and for granting permission to publish it. The letter is not in the author's own hand and is marked 'Copy': it is believed the family may have made copies to send to other relatives.

Text (St Andrews University Library, Special Collections, ms dep 121-8-2-15-1-4)

[Editor's Note: Some small amendments have been made to the punctuation of the original to improve the clarity of the account.]

22 June 1893: Tripoli

Today I have witnessed the most awful catastrophe in the loss of the *Victoria* – no doubt England is resounding with it now. As far as we know only 205 have been saved out of the 649. I am afraid poor Heath[1] is gone; Bourke[2] and Jellicoe[3] we hear are saved, and we have a young Sub-Lieutenant who seems to have kept his presence of mind wonderfully – he remembers going down–down–down and coming up, and going down twice more, then he was floating a quarter of an hour before he was picked up by our boat. A boatswain we saved declared he was sitting in his Mess when the *Camperdown*'s ram came through and that he crawled through the hole on to the bows of the *Camperdown* but came back to save a sick chum.

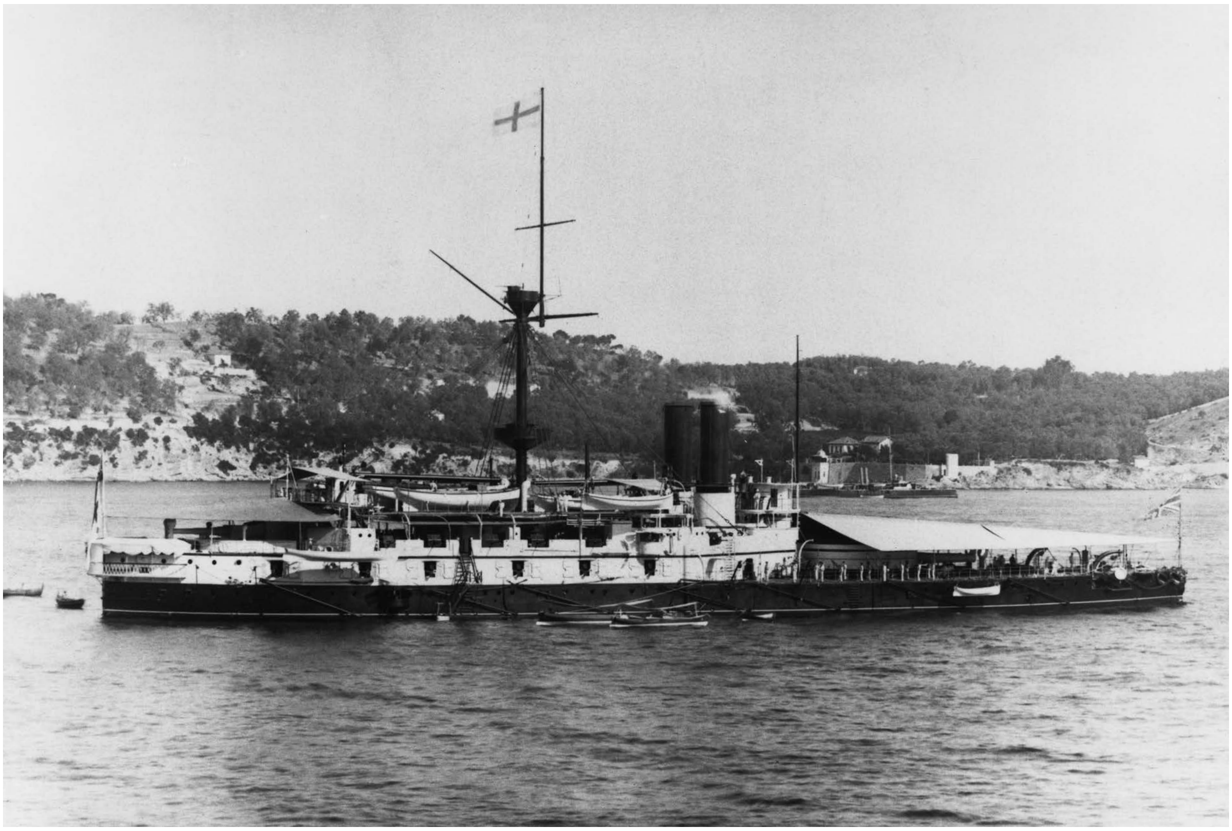
It occurred like this: we had passed the anchorage, and were going to turn back when the Admiral made a signal to the two columns to turn inwards; they were too close to have a chance of turning clear, which he must have forgotten, and the *Camperdown* took her fair on the starboard bow. There seems to have been no idea they were *in extremis* on board her, there was no confusion or panic, and the Admiral even made a signal 'do not send boats' thinking they were safe, I presume, but 12 minutes after the collision she lurched to starboard and turned turtle completely – we saw scores of men run across the bottom of the keel as she went down with the screws still working. Two boilers burst shortly afterwards and the sea was in a turmoil all round. I saw hundreds of men come to the surface, and if only boats had been near many more might have been picked up, but Captains were hampered by the Admiral's signal. On board here I sprang into a boat to save men drowning before my very eyes, and so saved several more lives. My God, to think of those Stokers down below! What nerve they showed to stay calmly below, working the engines when they knew the ship was rammed – it makes one's blood run cold. There was a ship, left harbour in all her pride as the leading ship of the world you may say, and now she lies 70 fathoms deep, in peace, no war, all in a moment, through the error of one moment's misjudgement (we presume). I felt nothing at the time but that one ought to get there, but now its full force rushes on one – at the time I felt perfectly cool. Let us pray for all ships at sea, and that we may face death as calmly as those fellows did.

23 June 1893: off Tripoli

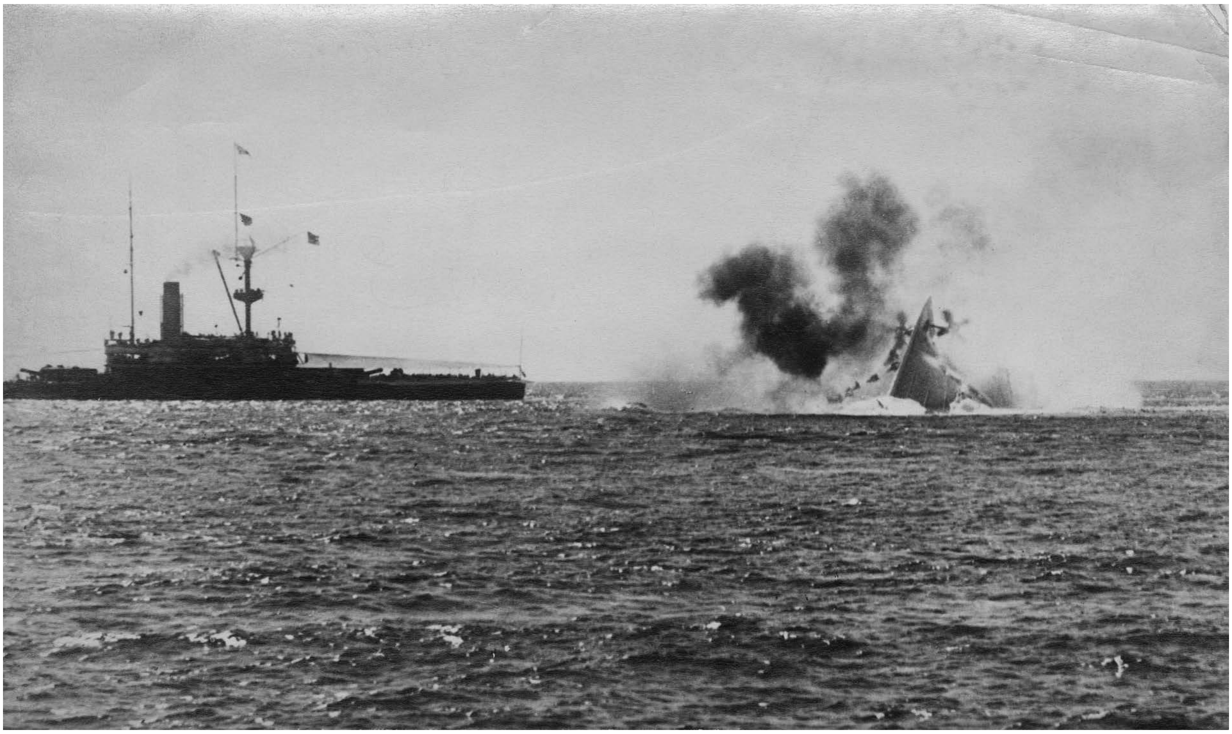
You will be glad to know that Heath is saved, I saw him at the Funeral today; in all 29 out of 57 officers and 101 out of 598 men are saved. It is said poor George Tryon's last words were 'It is all my fault'. He was the first tactician of the day – immaculate one would have said. It has cast a gloom over the whole Fleet & we are all very miserable.

24 June 1893

I have just time to tell you of the solemn Service ordered by the Rear Admiral[4] to be held on board every ship half an hour before sunset – all the officers in cocked hats, all the ensigns at half-mast, men standing. We sang 'Jesu, son of Mary, hear' and the XCth psalm, then the Captain[5] read the prayer in the Burial Service just before the Collect and the Collect, followed by the Lord's Prayer and the Blessing, then the hymn 'My God, my Father'. He quite broke down over the Service, poor old chap; I



HMS *Victoria* (seen here at Villefranche) and her sister *Sans Pareil* were turret ships completed in 1890 and 1891 respectively; *Nile*, completed in 1891, was similar. *Camperdown*, which collided with *Victoria*, was a barbette ship of the 'Admiral' class completed in 1889. At the time of the disaster these were among the most modern and powerful battleships in the Royal Navy. (CPL)



The famous photograph of *Victoria* sinking, her propellers still turning and crew members sliding down her upturned hull. This picture was taken from on board HMS *Collingwood*. (CPL) used your Church Service [book] for the first time, I have written in it for a memorial. Then 20 minutes before sunset the *Sans Pareil* began firing minute-guns as she had Admiral Tryon's flag at half-mast. At the 17th gun all the Guards presented arms, all the bands played Admiral's salute, the flag was slowly, slowly lowered as the sun sank lower and lower, and the salutes turned to a 'Dead March'. Then ensigns were hoisted and hauled down as usual for sun-set. I can see poor Bourke, through my glass, on board *Nile*; he looks very much cut-up.

Robert

Commentary

In June 1893, Robert Hamilton Anstruther (1862–1938) was a Lieutenant on board the cruiser *Phaeton*, which was the last ship in the column of six led by the *Victoria*. She would thus have been 1600 yards astern of the latter at the time of the collision, but much closer when the battleship sank.

At first sight, Anstruther's letter seems to add little but a few personal details to what is available in the accounts by authors such as Richard Hough[6] and Andrew Gordon.[7] However, it does bring out one significant point. The day after the disaster Anstruther, a junior officer in one of the least important ships of the Mediterranean Fleet, was already aware of Admiral Tryon's last words: 'It is all my fault', which were heard only by two surviving officers who had been with him on the bridge. He quotes them in the shorter form mentioned at the court-martial in July by Lieutenant Lord Gillford, rather than the longer version of Staff Commander Hawkins-Smith, so presumably the information had come from the former. It must evidently have been the talk of the Fleet, but this vital admission was not made public until Gillford, reluctant as he was to criticise his Commander-in-Chief, revealed it.

The papers surviving at St Andrews include only a selection of Anstruther's letters so we do not know, for instance, what he made of the court martial, and indeed he does not often comment about naval affairs in general. In a letter to his mother on 2 July, he remarks on the care that had been taken to look after the *Victoria's* survivors (some of whom the *Phaeton* had carried to Malta) and points out that the *New York Herald* had printed the news of the disaster 24 hours before *The Times*, a failure that he attributes to the lethargy of the Admiralty.

Robert Anstruther ended his naval career in 1916 as Senior Officer on the Coast of China, and retired as a Vice Admiral.

Endnotes:

[1] Lieutenant Herbert Heath, acting Executive Officer of *Victoria* during Jellicoe's illness.

[2] Captain Maurice Bourke of the *Victoria*.

[3] Commander John Jellicoe (the future Admiral of the Fleet), then Executive Officer of the *Victoria*, but confined to bed with a fever.

[4] Albert Markham, who flew his flag in the *Camperdown*.

[5] Reginald Custance.

[6] Richard Hough, *Admirals in Collision*, Hamish Hamilton (London 1959).

[7] Andrew Gordon, *The Rules of the Game*, John Murray (London 1996).

RESURRECTING *LCT 7074*

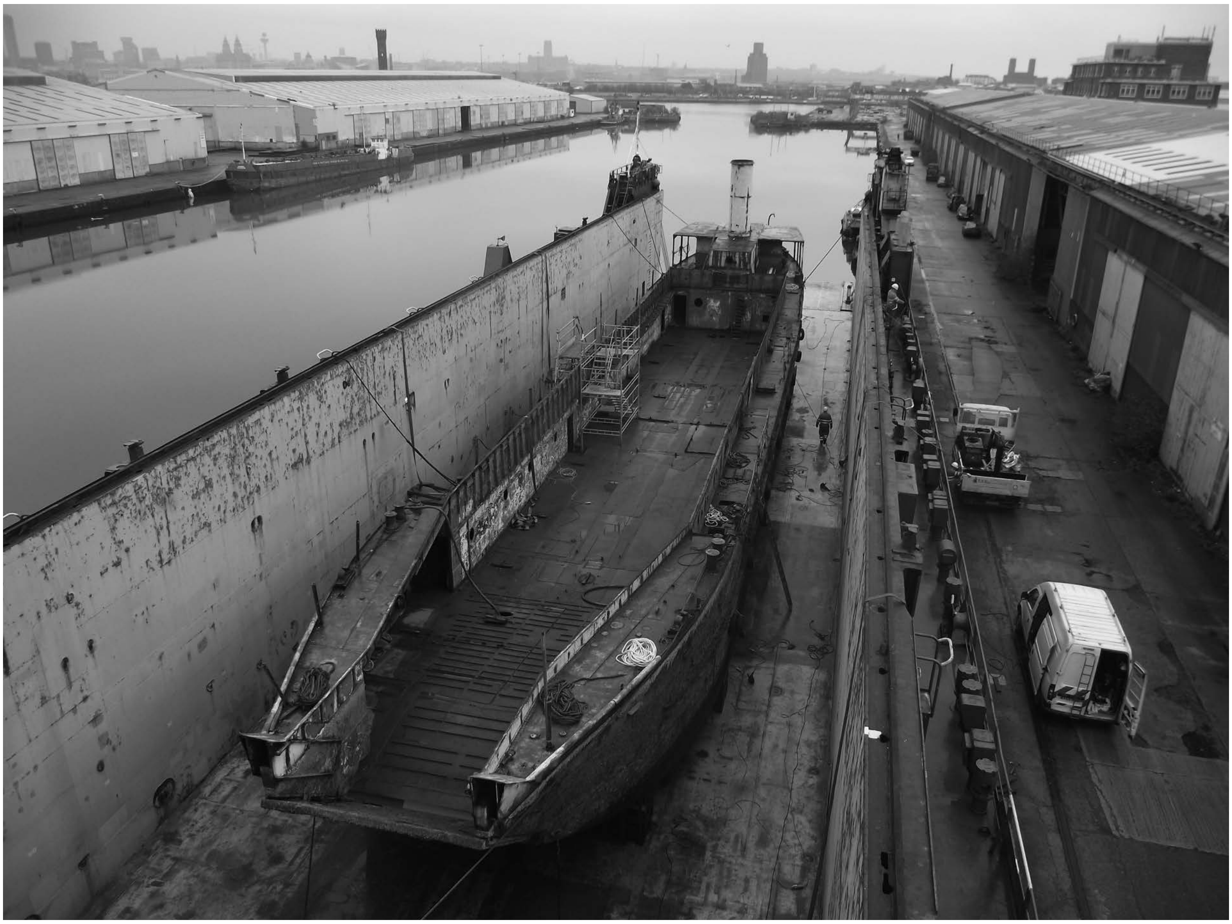
Stephen Fisher and **Nick Hewitt** of The National Museum of the Royal Navy describe the rescue and restoration of a D-Day veteran.

In early 2014, The National Museum of the Royal Navy was approached by National Historic Ships UK (NHSUK), the government advisory body, and asked to intervene to save *LCT 7074*, a Second World War landing craft, then lying on the River Mersey. Although listed as part of the National Historic Fleet, NHSUK's highest tier of significance (Certificate 713), the ship was in a sorry state. She had been acquired by the Warships Preservation Trust in the late 1990s, but the Trust had gone into liquidation in 2006. The ship was moved to a desolate corner of Birkenhead Docks, and by 2009 had sunk at her moorings.

Salvaging a sunken 350-ton steel ship takes time and resources, but in 2014 time was short. The site was being redeveloped and it was clear that *LCT 7074* had to be 'off the premises' as soon as possible, either intact or as scrap. However, it wasn't even known if the ship's hull was still viable. Much of 2014 was spent surveying her, while simultaneously working with the National Heritage Memorial Fund (NHMF), the 'fund of last resort' for heritage at risk, to devise a plan. Salvage divers from Salvesen UK made more than 100 dives, swimming/wading around *LCT 7074* and burrowing into the mud underneath her, testing her plates for soundness. This painstaking, filthy work took place in parallel with planning sessions with naval architects, master mariners and salvage experts from Comet Technical Support, project managed by Artelia UK.

LCT 7074 to *Landfall*

It was a sorry situation for a D-Day veteran to find herself in. Built as a Mk III Landing Craft Tank by Hawthorn Leslie at their Hebburn shipyard, *7074* was part of an order for 75 LCTs built in early 1944 to support Operation 'Neptune', the assault phase of the Normandy landings. Arriving at the beaches on the evening of 6 June, her landing was delayed until the following morning when she beached on Gold Jig Beach and disgorged units of the famous 7th Armoured Division (the 'Desert Rats'). She spent the following months moving men, vehicles and supplies from the Solent to Normandy until, in October, she moved to Dover and supplied Northern France and Belgium. Finally, her European service complete, she moved to Liverpool where work began to convert her to a Naval Service Craft (NSC), a floating landing craft repair facility for service in the Far East. However, just as the



After being raised from Canning Dock, *LCT 7074* was transferred to the MV *Condock* for her journey to Portsmouth. (National Museum of the Royal Navy)

conversion was completed, the conflict in the Pacific ended. Instead, in 1947, she became a floating clubship for the Merseyside Master Mariners Club in Liverpool's Canning Dock and then, in the 1970s, a nightclub in Collingwood Dock.

By autumn 2014 the landowners at Birkenhead Dock had gifted the ship to the National Museum and NHMF had awarded the project £916,000. The salvage took place on 15–16 October 2014, a tense period for all as there was still no guarantee that the ship's back would not break under the strain of lifting. LCT *7074* was refloated by gradually inflating giant air bags inside her while a floating crane kept her steady, and providing lateral movement to break suction with the dock bottom. After several hours a stream of tiny bubbles indicated that suction had been broken and after that she came up quickly – and in one piece.

Over the next month around 80 tons of mud, marine growth and other assorted filth was returned to Birkenhead Docks, before the floating dock ship *Condock V* took *LCT 7074* to Portsmouth. On 1 December 2014, she slipped into the enormous Ship Fabrication Hall, previously used to build large sections of the Royal Navy's new aircraft carriers, which HM Naval Base Portsmouth and BAE Systems had generously allowed the museum to use. The team inspected their new asset and worked out what to do next.

'Next' meant an application to the Heritage Lottery Fund (now the National Lottery Heritage Fund), the only funder capable of supporting such a challenging project. However, before the museum could apply, key decisions had to be made about the ship's future. Although *LCT 7074*'s history was long and varied, her significance lay in her direct association with Operation 'Neptune'. Thus, although due consideration was given to locating *7074* inside Portsmouth Historic Dockyard, or in the National Museum's northern base at Hartlepool near where the ship was built, ultimately only one permanent home ticked every box: the D-Day Story (DDS) on Southsea Common, the UK's only museum dedicated to Operation 'Overlord'/ 'Neptune', owned and operated by Portsmouth City Council. The council's response was enthusiastic, and in partnership the two organisations began to construct a programme. Three other key decisions came at the same time. Given the fragility of her fabric and the amount of 1944 material which would be lost making her seaworthy again, it was clear that *7074*'s future must lie ashore. She would be restored to her June

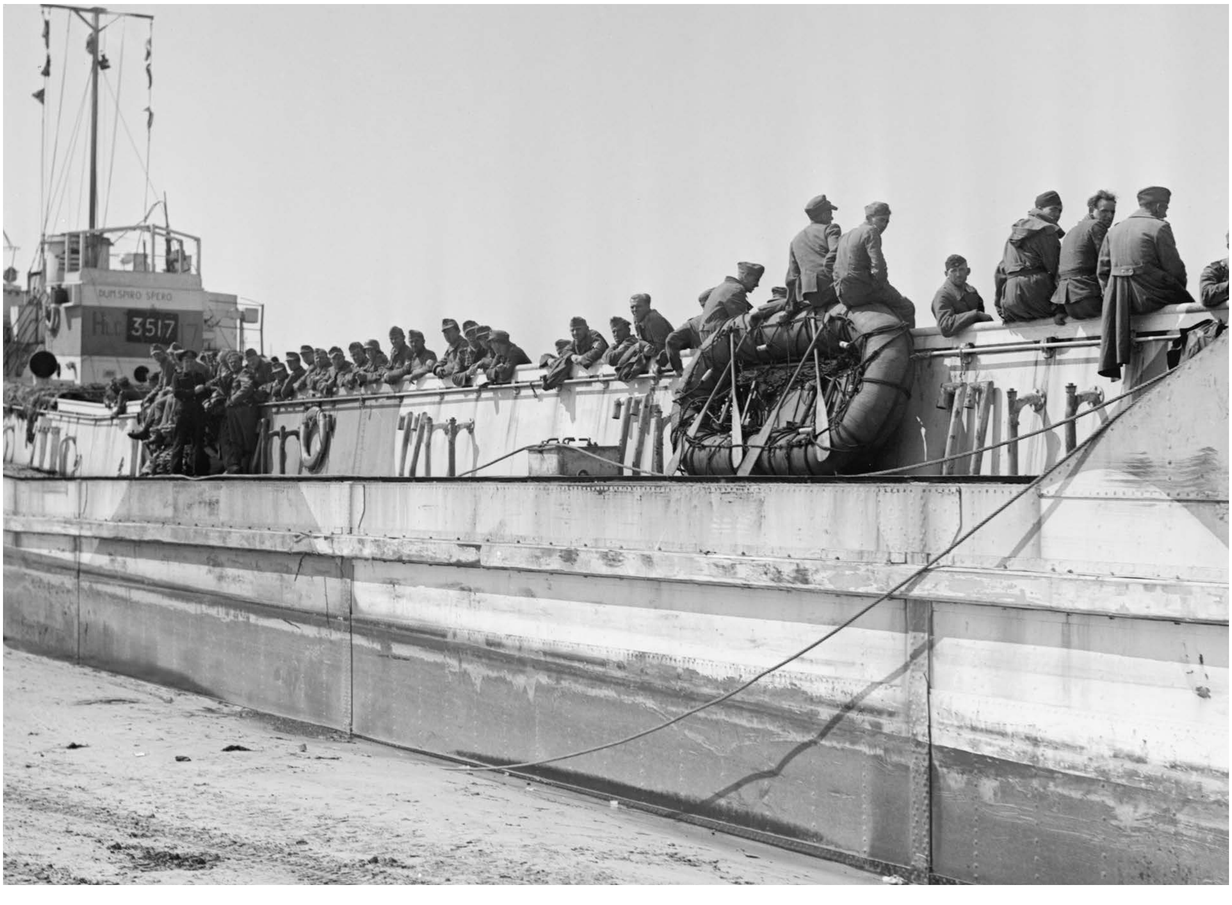
1944 configuration, although the project would record legacy evidence of her later uses. Finally, although the ship would remain the National Museum's asset, she would be operated by DDS and exhibition elements should be consistent with that museum's galleries.

During the 1950s and 1960s, when *LCT 7074* was berthed in Liverpool's Canning Docks, renamed *Landfall*, modified substantially and no longer even recognisable as a landing craft, knowledge of her early history was lost. When she came to leave Canning Dock in 1971, the *Liverpool Echo* ran a few short pieces on her life. Referring to her as a 'Canadian built wartime tank carrier', it observed: '*LCT 7074* never attacked an enemy beach. She was used as a navy depot ship.' In two short articles the paper came close to formalising a false history of *7074*'s service. However, shortly afterwards Philip Stephens, *7074*'s former first lieutenant, got in touch to set the record straight. Within a month, the *Echo* had run a piece on her 'proud record'. George Evans, the new licensee of the clubship, noted that it filled in some useful gaps, as the recorded history that he had acquired dated back only to 1947. In 1972, Evans self-published *The Landfall Story*, which included a brief account from Stephens, providing key dates, units and locations associated with *7074*'s D-Day role. Without this intervention, *7074*'s story might never have been uncovered; instead the D-Day connection may well have been crucial to saving her. These brief reminiscences from her first lieutenant also provided a vital head start in the deeper research that has accompanied the restoration.

Researching *LCT 7074*'s story

Any investigation into the details of a landing craft's service at Normandy begins in The National Archives, with a look at the orders documents issued to the naval task forces that sailed to each of the beaches. Stephens' diary already showed that *7074* had been part of Force L, the follow-up force that landed troops and vehicles on Sword, Juno and Gold Beaches behind the initial task forces (Forces S, J and G respectively). Close inspection of the orders for this task force soon identified key information relating to her story, in particular her Landing Table Index Number (LTIN).

LTINs were code numbers assigned to troops and vessels for D-Day that established the order in which they were expected to land. In principle this simplified the entire embarkation process in the days before 6 June, but it can be difficult to match a vessel's pennant number to its LTIN. Fortunately – and unusually – *7074*'s flotilla was included in a master list of LTINs in the Force L



LCT 7074 beached on Gold Jig Beach on 7 June 1944. The landing craft was used to collect prisoners of war, mainly Eastern European conscripts. Her Landing Table Index Number, 3517, is visible on the bridge. (Courtesy of the Trustees of the Imperial War Museum © IWM A 23941) orders. With this key detail, it became possible to extract a host of other information: embarkation orders, load and sailing instructions.

Within days there was another breakthrough when the researchers chanced upon a photograph showing the same LTIN on the bridge of an unidentified landing craft on Gold Beach in France. The photograph was one of a series taken by a Royal Navy photographer on 7 June and was quickly matched to a series shot at around the same time by a sergeant from the Army Film and Photograph Unit. From these it was possible to confirm the LTIN: in some images *7074*'s pennant number could be discerned on the hull, and in others the LTIN of the same vessel could be seen on the bridge. By identifying key landmarks, it was even possible to identify exactly where *7074* was beached. The details in the orders documents and the photographs all corresponded with Stephens' brief account.

Backed by this growing historical narrative, the National Lottery application began in autumn 2016 with a Project Enquiry. Round 1 was submitted on 16 March 2017, the project passed, and a more detailed Round 2 went in on 14 June 2018. The project was awarded just under £5 million in October 2018. With the Museum's commitment to raise just over £1 million in matched funding, this made for a £6 million project. At each stage, the project plan grew in scope and detail, with numerous museum and DDS colleagues and specialist consultants joining the team: conservators and curators supported by volunteers; naval architects, marine engineers and steelwork specialists; conservation and landscape architects and building contractors; interpretation designers, exhibition fit-out teams and audio-visual exhibit designers.

Research work continued and by now a detailed timeline of *LCT 7074*'s movements – from the moment of her launch at Hawthorn Leslie in April 1944 to her transfer to Liverpool in April 1945 – had been constructed. Inevitably, there are gaps in the available history: although there are detailed reports from the various commanders of the flotillas that sailed in Forces S, J and G, there are no final reports from Force L. Beyond Stephens' own brief record, there are no details regarding *7074*'s continued role transporting men, vehicles and supplies to Normandy, Northern France and Belgium. Even the war diaries of the units embarked on *7074* for D-Day are insufficiently detailed to piece together their fate after disembarking on Gold Jig Beach.

Fortunately there are alternative windows into these details. A comprehensive trawl of photographs of tanks in Normandy soon threw up a significant clue: a picture of a Sherman tank knocked out in the town of Villers-Bocage. This Sherman, commanded by Major Denis Wells of the 5th Royal Horse Artillery, was notable for being knocked out by German tank ace Michael Wittman during a critical engagement on 13 June. Crucially, the tank's LTIN was clearly visible, chalked onto the hull by her crew in advance of embarkation. It perfectly matched the loading orders for *7074*. Another lead came from Stephens' mention of taking large cranes to Antwerp in March 1945. A hunt through military reports from this period eventually identified the unit concerned and provided a detailed account of its time in Europe. The sailing dates matched Stephens' description, and even confirmed that LCT Mk III were used as they were the only vessels that could fit the cranes on the tank deck.

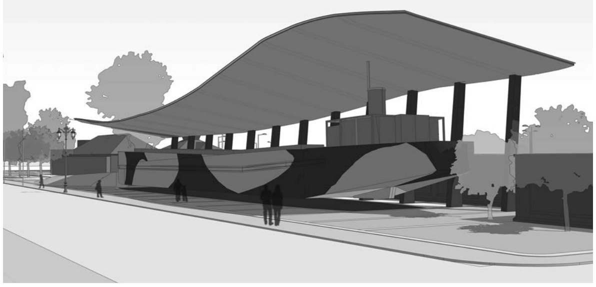
Further clues come from the accounts of other veterans. The archive of the now-disbanded LST and Landing Craft Association (held by DDS) contains numerous accounts from crew on sister vessels and other craft in Force L. Using these accounts, it has been possible to extract more of *7074*'s own story and get a much better idea of life aboard these vessels.

Restoration and preservation

Restoration work began in earnest in January 2019. The main steelwork contractor, MLUK, began an intensive programme, following NHSUK's approved methodology, with every stage painstakingly surveyed and recorded against the ship's Conservation Management Plan and filmed by a specialist production company, Maritime Films. Perhaps the hardest decision came at the outset. The ship's double bottom was a lattice construction with countless small, inaccessible spaces, each of which had to be dried out and treated if the ship was to survive. The only options were to lift the tank deck, arguably the most archaeologically sensitive part of the ship, with no guarantee that it could be replaced, or to make dozens of holes in the ship's bottom. In the event the latter option was selected as having the least impact on the ship's appearance, as the underside would not be seen by visitors. The holes were left open, to ensure that the spaces would always be accessible to the Museum's conservation team.

Archaeologically recording *LCT 7074* was perhaps one of the most important elements of the restoration. Innocuous details such as the remains of welds on the deck could identify exactly where certain fixtures had been fitted on the vessel. By studying the layers of metal brackets attached to bulkheads it was possible to see the order in which changes were made to the vessel's layout

The archaeological survey of *LCT 7074* has made sure that her restoration is as accurate as possible, and ensures a permanent record of the changes she has undergone. (Ronin Archaeology)



An artist's impression of *LCT 7074* at her final berth outside the D-Day Story on Southsea Common. (Courtesy of Pritchard Architecture)

over her career. Recording the changes made between 1945 and acquisition by the Warships Preservation Trust was just as important as understanding her 1944 arrangement – *LCT 7074* is not only the last surviving LCT from Normandy (only two other LCTs survive, but neither saw service in Northwest Europe), she is the only surviving Mk III and the only surviving vessel converted to an NSC. Completing a comprehensive record of her arrangement before restoration, as well as the changes made to restore her 1944 appearance and make her a safe and accessible visitor attraction, ensures that future generations understand exactly what has been done and why.

Six weeks of ultra-high-pressure water blasting forced years of accumulated salts out of the hull and stripped off marine growth and corroded, delaminated steel until only solid fabric remained. Then, as the hull dried out the team began to fabricate patches for scuttles and windows cut after 1944, and to construct missing elements, including zareba gun shields for her anti-aircraft guns, a mast, and a new, working bow ramp (replacing a badly corroded blanking plate) which will form the ship's entrance once she is on public display.

At the same time, work began at DDS to construct a robust support system with a canopy roof to protect the ship from the worst of the elements. The ship will sit inside a huge trench, essentially a dry dock, with cement pilings functioning as dock blocks, topped by adjustable screw jacks to ensure that every plate will be accessible for future inspection intervention. Hard and soft landscaping will flow seamlessly into that of the D-Day Story.

Interpretation will be kept low-key and experiential with the aim being to recreate as closely as possible the atmosphere aboard *LCT 7074* as she crossed to Normandy in June 1944. Much of the ship will be dressed with props representing personal clothing, equipment and possessions, supported by ambient sound allowing visitors to hear the sound of tank engines revving, or conversations between soldiers and sailors. Two tanks previously displayed outside DDS will be restored and installed on the ship. Only the engine room will be self-consciously a 'gallery', its plating and bulkheads treated with conservation wax but remaining unpainted to give visitors a flavour of the ship's 'as found' condition. Interactive exhibits will explain how *LCT 7074* worked and tell the stories of the people who built her, operated her, and travelled to Normandy in her.

The final issue was to determine how best to transport *LCT 7074* to Southsea. At first, the team believed that the ship would have to be cut into sections and moved by road. This solution was far from ideal, but over time it became clear that the option existed to transport her in one piece. In April 2020, the ship will be towed to Southsea on a semi-submersible barge, where a shingle ramp will be constructed to bring the beach level with the adjoining roadway. *LCT 7074* will then be rolled ashore and along the road to her new home on a Self-Propelled Modular Transport system. However, as with D-Day itself, the operation hinges on unpredictable environmental factors. The earliest possible move will be April 2020, but with only four days each month offering sufficiently high tides, if the weather is bad the team will have no choice but to postpone for a month.

The ship's arrival will be spectacular, but it remains the project's last great period of uncertainty. However, if all goes well, by the time *Warship* readers see this article, *LCT 7074* should be on Southsea Common, resplendent in her Admiralty-pattern disruptive camouflage and undergoing the final stages of fit-out before she opens to the public.

Notes:

Nick Hewitt is the Head of Exhibitions and Collections at The National Museum of the Royal Navy and is overseeing the *LCT 7074* 'Resurrecting a D-Day Hero' project. Stephen Fisher is the heritage consultant, responsible for recording the archaeology of the vessel and researching her history. For further details of *LCT 7074*, visit: https://www.nmrn.org.uk/our-museums/lct-7074.

A's & A's

JAPAN'S U-BOATS (*WARSHIP 2018*)

Aidan Dodson has supplied further information on former German U-boats.

Since my 'A&A' in last year's *Warship* was written, further information has come to light about the two 'Belgian' U-boats. It now transpires that the submarine placed on short-term loan to Belgium was *U-90* – and that she never reached her intended destination, being lost in tow 12 miles off St. Catherine's Point, Isle of Wight on 29 November 1919. *UC-92* was retained by the UK and expended in explosive trials at Falmouth in 1921, where her remains still lie.

Further detail on these and other matters to do with the fate of surrendered German submarines, including significant correction to previously-published data, will be found in A Dodson & S Cant, *Spoils of War: The Fate of Enemy Fleets after Two World Wars* (Seaforth, 2020).

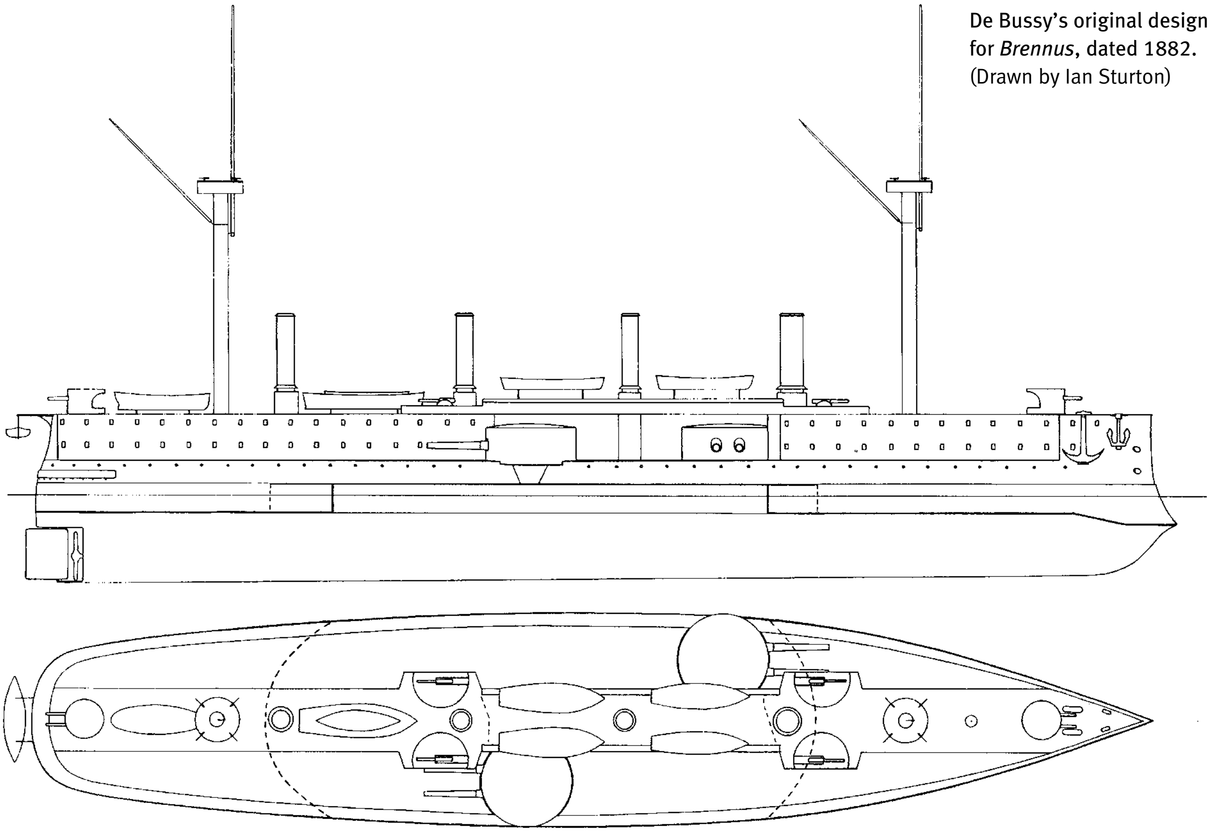
THE FRENCH BATTLESHIP *BRENNUS* (*WARSHIP 2019*)

Regular reader and occasional contributor **Ian Sturton** has submitted the following additional information about the design of *Brennus*.

Philippe Caresse's account of the genesis and gestation of *Brennus* does insufficient justice to the design process. The various proposals are outlined in the table and illustrated in the accompanying plans.

As noted in the article, the de Bussy design was approved by the *Conseil des Travaux* on 27 May 1882, although the *Conseil* preferred open barbettes for the main armament; voting was tied 7-7, with the President casting his vote in favour of barbettes.

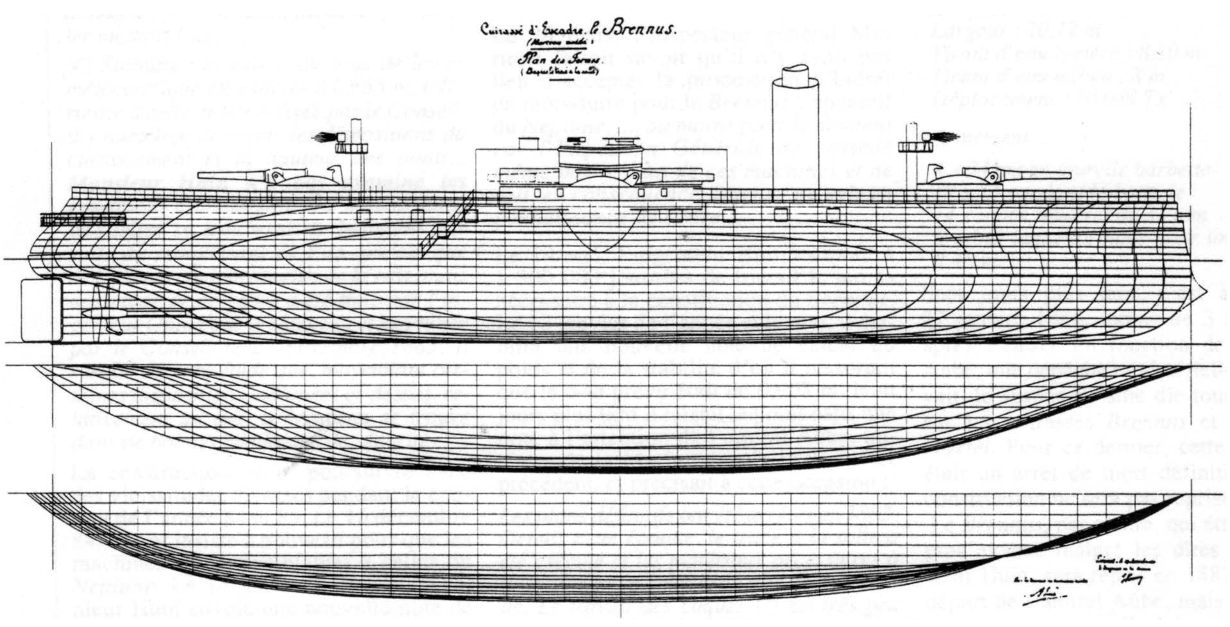
De Bussy's proposed layout was similar to that of the



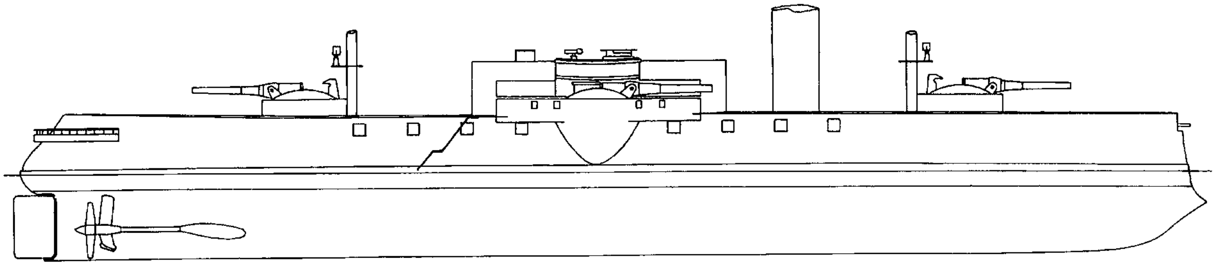
De Bussy's original design for *Brennus*, dated 1882. (Drawn by Ian Sturton)

Brennus: Stages of the Design Process

Designer	De Bussy	Huin	Huin
Date	1882	1884–85	1887
Displacement	9,742 tonnes	10,649 tonnes	11,395 tonnes
Dimensions (lxbxd)	105m pp x 19.4m x 7.6m	107.6m pp x 20.1m x 7.6m	110.3m pp x 20.4m x 8.4m
Armament	4 – 34cm/28 (2 x II) 8 – 14cm (2 x II, 4 x I) [smaller]	4 – 34cm/28 (4 x I) 17 – 14cm (17 x I) 6 TT 14 – 47mm 14 – 37mm	3 – 34cm/42 (1 x II, 1 x I) 10 – 14cm (10 x I) 4 – 65mm (4 x I)
Armour	compound	?	compound and steel
belt (amidships)	440–250mm	450–300mm	400–250mm
belt (ends)	–	300–200mm	300–180mm
bulkheads	440mm-250mm	–	–
deck	75mm	80mm	60mm
main turrets (max)	350mm	–	455mm
barbettes	–	380mm	–
Machinery			
boilers	24 (four groups)	8 (four groups)	32 watertube
screws	3	2	2
horsepower/speed	10,350ihp / 17kts	5,500ihp / 15kts	12,500ihp / 17kts



Body plan for Huin's design of 1884.



Profile of Huin's design for *Brennus*, dated 1884. (Drawn by Ian Sturton)

Italian and British citadel ships, but with armour arrangements as in the British 'Admirals' (described officially in London as of the 'modified citadel type'). Waterline armour was limited to a shallow belt 50.8m long and only 2.6m deep (1.6m below and 1.0m above the waterline). Protection at the ends was confined to the underwater deck and extensive subdivision. In this form, *Brennus* was the first French seagoing battleship designed from the outset with turrets for the main armament and one half of the secondary armament, with three screws, and without sails. The ram was retained.

Brennus was laid down to the Huin design 2 January 1885 (*100 ans de Marine Française, un hors-série de Marines,* No 1, April 2002, 31). In January 1886, shortly before Vice Admiral Aube suspended work on *Brennus* (and *Charles-Martel*) *sine die*, the hull was only 0.5 per cent complete, while the machinery (from Indret) had not been ordered.

In considering the resumption of work on *Brennus* to an entirely new design, a note dated October 1887 stated that 482 tonnes of material were fully worked and ready for assembly, and a further 801 tonnes were in hand and partially worked; some 213 tonnes had been removed for use in other ships, and around 1,323 tonnes remained in storage.

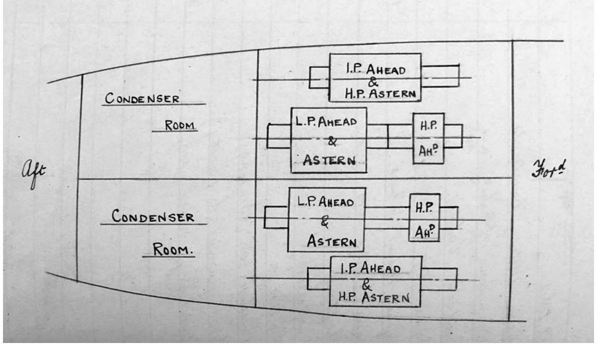
The subsequent progress of *Brennus* may be traced from the French Naval Estimates detailed in successive *Brassey's*: order for construction 31 December 1887; commenced January 1889; ship 2% complete on 1 January 1889, 16% on 1 January 1890, 36% on 1 January 1891, 62% on I January 1892, with 25% to be added during 1892.

Sources: Luc Feron, article in Marines Guerre – Commerce Nos 14–19 (1991-92), except where otherwise stated.

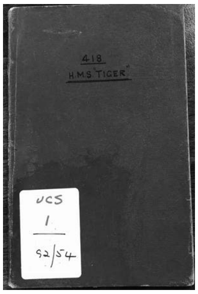
BATTLECRUISER *TIGER* (*WARSHIP 2019*)

Author **Brian Newman** has written in with some new information which confirms his thesis about the propulsion machinery of HMS *Tiger*.

That immutable law which frustrates completeness of research until after publication was once again enacted when, just after the deadline for amendments to my *Tiger* machinery article for *Warship 2019* passed, a new and important piece of supporting evidence came to light. It did so courtesy of Professor Ian Buxton, who, on a visit to Glasgow University Archives, found a notebook from the Clydebank shipyard which contains the accompanying drawing confirming the conclusions I



Above: The John Brown schematic showing the arrangement of *Tiger*'s machinery. (Archives Services, University of Glasgow, UCS1/ 92/54)



Right: The cover of the John Brown notebook for HMS *Tiger* held in the University of Glasgow archives.

had made about the arrangement of the machinery in *Tiger*.

As the article demonstrates, incorrect information is easily propagated, and this is further exemplified by one of an otherwise authoritative series of articles in *Model Engineer* as recently as 15 February 2019 on the principles of full size and model steam turbines by Mike Tilby. This included a photograph of the turbines of '*Repulse*' in the erecting shop at Clydebank: except of course, they were not for that vessel but for *Tiger*, as illustrated on page 76 of my article. I drew attention to the incorrect attribution of this photograph on page 79, but little did I expect the error would be repeated almost exactly one hundred years later by reference to its original misleading inclusion in *The Engineer*.

I would like to record my gratitude to Ian Johnston for many late-night telephone conversations and for his great expertise in taking the visual presentation of the article way beyond the capabilities of its author, and to Professor Ian Buxton for some obscure and valuable sources.

BATTLECRUISER TIGER (*WARSHIP 2019*)

Warship reader **Takagi Hiroshi** has written in to point out that there are two errors in the labelling of the schematic drawing of HMS *Tiger*'s machinery we published on page 78 (Fig 8):

1 Dotted line 2: direction should be from rear to front of the IP turbine front stages.
2 Dotted line 3: output should be from front of the IP turbine front stages.

As evidence he has supplied the accompanying schematic of the Brown Curtis turbines mounted in the IJN battleships *Fuso* and *Yamashiro*.

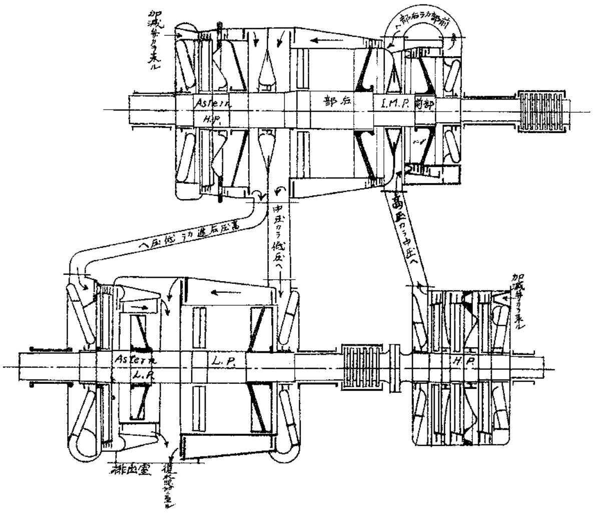
We asked the author of the article, **Brian Newman**, to comment. His response is published below:

I welcome Mr Takagi's contribution to the debate on *Tiger*'s machinery and consider him fortunate indeed to have detailed drawings of the Brown Curtis turbines in *Fuso*. Sadly, no such fortune attended my research into *Tiger*, as only two drawings of the engine room (Figs 1 & 3) were identified from the collections at the National Maritime Museum (Brass Foundry, Woolwich), Glasgow University Archives, and the National Records of Scotland.

My article therefore proceeded on largely textual evidence supported by just fifteen photographs of the machinery under construction, none of which showed the IP turbine casing. In the circumstances the drawing showing the arrangement of the machinery (Fig 8) was of necessity a schematic one, its dimensions approximated from the photographs, the intention being to illustrate the layout of the turbines in the most general way. I therefore consider the term 'error' used by Mr Takagi to be inappropriate: my drawing simply lacked detail, detail for which no source specific to *Tiger* had or has subsequently been identified and could not therefore have been discussed in the article.

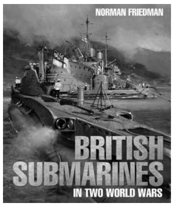
Mr Takagi's comment is undoubtedly correct in the context of the sale of Curtis turbine designs to Japan for *Haruna*, *Hirado* and *Chikuma*, and crucially for *Fuso*. However, from the evidence available in the UK for *Tiger*, it was impossible to be precise with regard to the arrangement of the steam lines, and both the article and the schematic drawing reflected this. Given these constraints, I am grateful to Mr Takagi, because his observation adds materially to the debate.

Finally, I would like to add that the development of the Curtis marine turbine in Japanese warships may be of significant historical interest, and research into the subject a potentially rewarding one for the serious student of the subject.



Schematic drawing of the Brown Curtis turbine arrangement in *Fuso* and *Yamashiro*.

NAVAL BOOKS OF THE YEAR



Norman Friedman

British Submarines in Two World Wars

Seaforth Publishing, Barnsley 2019; large format hardback, 432 pages, many B&W photos and plans; price £50.00.
ISBN 978-1-5267-3816-5

This massive tome is the latest in Norman Friedman's Seaforth series on warship types of the Royal Navy. Like the earlier books it is a technical history, focusing primarily on development in the light of perceived strategic and tactical requirements and lessons learned both in peacetime and in war. Coverage is unusually ambitious, beginning with the earliest RN submarines of the *Holland* type and ending with late-WWII 'A' class and a glimpse of possible futures.

At the beginning of Chapter 7 the author states, perceptively: 'Unlike other navies, the Royal Navy bought its first submarines to learn how to neutralise other submarines'. Nevertheless, by the end of the Great War of 1914–18 the Royal Navy had arguably the most capable (and certainly the most innovative) submarine force in the world, and had developed a range of important missions: coastal and harbour defence ('A' to 'C' classes), close observational blockade of German harbours ('D' and 'E' classes), and offensive minelaying. Fast 'fleet' submarines were intended to operate in conjunction with the battle fleet after Jutland, forming a patrol line across the enemy's line of retreat in the North Sea ('K' class), and three large submarines armed with a single 12in gun ('M' class) were completing.

Following an abortive attempt to abolish the submarine at the Washington Conference of 1921–22, the Royal Navy embarked on the design of submarine types to match a new, much-changed strategy that focused on operations against Japan in the Far East – operations which implied endurance and long-range communications. This policy was turned on its head by the London Treaty of 1930, which placed a ceiling on overall tonnage (and therefore favoured the construction of larger numbers of smaller boats), and by a renewed focus on the European theatre in the lead-up to the Second World War.

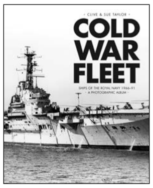
Friedman's book covers every aspect of British submarine development during the period: the early Vickers monopoly and its adverse consequences (heavy, smoky diesels, inferior periscopes), submarine command facilities (bridges, conning towers and control rooms), internal versus external torpedo and mine tubes, the employment (and housing) of deck guns, wireless telegraphy (W/T) and direction finding, the development of Asdic (both passive and active) and its influence on silencing measures, and the investigation of alternative 'closed-cycle' propulsion systems from the 1930s. Major chapters on the two world wars focus on strategic analysis, lessons learned, and the modifications to existing designs and development of new submarine types that resulted. Three appendices cover W/T development, midget submarines, and Vickers export designs.

The book is not without its flaws. The author's tendency to be distracted by the results of his own research sometimes leads him into 'side alleys', there are no fewer than 44 pages of densely-packed endnotes, and there are occasions when a concise table would have been preferable to lengthy and repetitive prose descriptions of the technical characteristics of competing design options. Virtually all the names of French submarines (including the seminal *Gustave Zédé*) are spelled incorrectly, and the American past tense 'dove' (UK English 'dived') has also survived editorial scrutiny. However, the depth of research and the quality of the analysis more than compensate for these small irritations.

The quality of illustration is outstanding. The photographs, many of which are courtesy of Dr Josef Straczek of the RAN Naval Historical Service, are stunning, and are generally reproduced to a good size with informative, well-focused captions. They are complemented by detailed plans – mostly reproduced in black & white, but with a colour gatefold section – which are either from the National Maritime Museum or by the late John Lambert (based on the official plans). The plans comprise inboard profiles, deck plans and section views, and constitute one of the highlights of the book. Most occupy a double-page spread, and although the profiles and deck plans would have benefited from being divided on either side of the gutter, the labelling is generally legible.

This book is sure to become the standard reference for British submarine development for years to come; it is a particularly impressive achievement, and good value for its £50.00 cover price.

John Jordan



Clive & Sue Taylor

Cold War Fleet: A Photographic Album of Ships of the Royal Navy 1966–91

Osprey Publishing, Oxford 2019; hardback, 304 pages, many B&W photographs; price £50.00.
ISBN 978-1-4728-3371-6

Naval enthusiasts of a certain age will be instantly familiar with the names of Wright & Logan, Walter Sartori, Leo van Ginderen, A & J Pavia as part of the eternal quest for the best photographs of a particular class or individual warship. To this illustrious list should rightfully be added C & S Taylor, who turned their 'serious hobby' into a specialist warship photograph agency of international repute. This book comprises examples of their high-quality, black and white photographs taken during the middle and late periods of the Cold War.

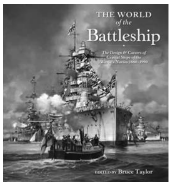
In the course of a self-effacing introduction, they claim that the work is not intended to be a serious reference book but rather 'a photo album of Royal Navy vessels covering a particular time-span'. Strictly speaking this is true, but the many merits of this large-scale publication raise it well above what might be superficially regarded as an expensive, 'coffee table' book.

Cold War Fleet covers not only practically the full range of Royal Navy ships and submarines themselves but also the wide variety of supporting vessels of the period, including RFAs, depot, experimental and other support ships, tugs, harbour craft and tenders. To their credit the authors point out that some ships (indeed some classes) constantly eluded them for various reasons – including the weather. Notably, there are no SSBNs, unsurprising perhaps as the Taylors were based in southern England and the movements of these Scottish-based submarines have remained unannounced over the past half century.

Separate chapters cover each vessel type in roughly chronological order. Thus, the frigate section starts with the war-built Type 15 destroyer conversions and ends with the Type 23 'Duke' class. Typically, a double-page spread consists of four or five related photographs accompanied by captions. The latter vary considerably in length, being anywhere between 30 and 150-plus words, and therein lies one of the true merits of the book. The authors are extremely knowledgeable on their subject and often make very precise observations about items of equipment or structural changes, some of which might otherwise be missed by casual or less well-informed eyes. This reviewer was thus introduced to new nicknames such as the 'Seasides' for the Type 12 *Whitby* class and the dismissive 'guided flagpoles' for Type 81 'Tribal' class frigates. The authors seem unclear about the exact function of the 'dunces cap' cone-shaped electronic warfare array at the foremast head of some of the *Leander* class but the term seems apposite enough. There is irony too in the selection of photographs. An immaculate-looking HMS *Bossington* entering Portsmouth Harbour is typical of countless RN ships down the years. However, an accompanying photograph shows the same MCM leaving the base with loose cables trailing and a poorly slung inflatable hanging over the side – one can just imagine the comments emanating from the nearby Semaphore Tower!

It is the quality of the photographs themselves which really make the book. The Taylors made wide use of aerial views, especially to capture arguably the last, great RN fleet review – for the Queen's Silver Jubilee in 1977. A large, double-spread overhead photograph of HMS *Tiger* adorns the inside cover. Function triumphs over form as her handsome cruiser lines are distorted by the bulky hanger and flight deck aft and the various protuberances of the missile age – the old and the new navy slightly uncomfortably merged. However, it is easy to become sentimental about such *fin de siècle* moments; *Cold War Fleet* is a snapshot of an era but also a reminder that navies, like most things in life, are constantly evolving.

Jon Wise



Bruce Taylor (ed)

The World of the Battleship: the Design and Careers of Capital Ships of the World 1900–1950

Seaforth Publishing, Barnsley 2018;
large format hardback, 440 pages,
498 B&W illustrations; price £40.00.
ISBN 978-1-84832-178-6

This handsome volume claims to present all the aspects of the age of the battleship through the careers of 21 vessels from the world's navies, in effect 'A Life and Times' of each ship. The title presents a certain awkwardness, as the expression 'Capital Ship' is not a precise synonym for 'Battleship'. The battleship, a large, heavily armed and armoured warship, was indeed the capital ship from about 1880, but was joined by the 'battle cruiser' around 1911. The 'capital ships' here total 21, from 21 navies; for Argentine and Greece, smaller, weaker armoured cruisers have been substituted for full-sized battleships. The Netherlands and Scandinavian countries lacked large armoured ships entirely, so coast-defence ships have perforce been chosen; a second cut-off, ship size, means that Peru, Portugal, Mexico and Thailand, which all owned small armoured ships, are excluded. Each chapter has been written by a specialist drawing on published and archival sources, resulting in the presentation of much material seldom seen in English-language naval books.

The selection of ships from the Great Powers is good except for the French Navy, for which a Second World War choice such as *Dunkerque* or *Richelieu* would have been preferable to the obscure (and short-lived) *Iéna*. Britain is favoured, as HMAS *Australia*, *Almirante Latorre*/HMS *Canada* and HMS *Hood*, together with Brazil's *Minas Gerais* all feature. Germany has *Goeben*/*Yavuz* and *Scharnhorst*, while Italian shipyards are well represented, with Argentine and Greek armoured cruisers and the *Littorio*.

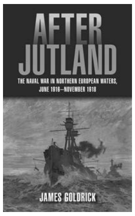
The ships selected, large and small, make possible accounts of surface naval operations in the Sino-Japanese War, the Russo-Japanese War, both World Wars, the Korean War and other conflicts. In the First World War, the Russian *Slava* participated in most Baltic campaigns, and similarly *Yavuz* in Black Sea operations. *Australia* and *Canada* were prominent in the North Sea and at Jutland; *Viribus Unitis* and *Averof* saw service in the Mediterranean. Much information on the Rif War and the Spanish Civil War at sea comes from the career of *Alfonso XIII*/*España*, while *Hood*, *Scharnhorst*, *Littorio*, *Nagato* and *Missouri* give a good spread for the Second World War. The map of Operation 'Weserübung' is helpful (there are no battle plans), as is the drawing of the Pugliese anti-torpedo system in *Littorio*.

The chapter authors, like their ships, are uneven, and the editor is to be congratulated on combining their accounts into a coherent whole. Unusual and occasionally sparkling background chapters offset the inclusion of ships of lesser technical interest. The Norwegian entry (coast defence ship *Eidsvold*) is good, containing details of the proposed defence against a possible Swedish *coup de main* during the 1905 separation of the two kingdoms, then neglect of the navy between the world wars, resulting in weaknesses scarcely remedied in the 'Phoney War' before the German invasion of April 1940. The accounts of Australian naval defence and of Austro-Hungarian geopolitics and nationalities are exceptional. There are some real surprises, for example a proposed 1945 Swedish amphibious landing at Elsinore to parry a feared Soviet drive across northern Germany into southern Denmark.

Mutinies in peace and war were numerous (Australia, Austria-Hungary, Brazil, Britain, Chile, Netherlands, Greece) and are examined fully and fairly. Some peacetime mutinies were the consequence of class or racial differences between officers and men, accentuated by brutal discipline; others originated in pay reductions imposed during the Great Depression.

Overall, there is a light sprinkling of minor errors in text and captions, but these aside this is a splendid book, admirably laid out and comprehensively illustrated with excellent black and white photos, many previously unpublished. Altogether the book is a remarkable *tour de force* and full of unexpected 'nuggets,' to be awarded five stars and take its place on any naval bookshelf.

Ian Sturton



James Goldrick

After Jutland: The Naval War in Northern European Waters, June 1916 – November 1918

Seaforth Publishing, 2018; hardback, 332 pages, illustrated with 32 B&W photographs and 13 maps; price £25.00.
ISBN 978-1-5267-4298-8

Rear Admiral James Goldrick's new book completes his accomplished account of the naval war before and after the Battle of Jutland (for a review of *Before Jutland* see *Warship 2016*, 195). He continues to focus primarily on operations in the North Sea, the Dover Straits and the Baltic by the British, German and Russian navies while briefly covering the contributions of the Americans and French. Thus he only glances at the enforcement of the blockade of Germany and at the wider U-boat war.

After Jutland begins with the strategic situation in June 1916 and a review of the three principal navies. This contrasts the relationships between officers and men, well managed only in the Royal Navy and helped, Goldrick suggests, by the British officers having to share the privations of life in Scapa Flow. The next chapter on Operational Challenges complements that in *Before Jutland*. While difficulties of navigation in northern waters hardly changed, Goldrick rather overstates British confidence after Jutland concerning an open-sea encounter with the High Seas Fleet. However, in order to take advantage of British numerical superiority, methods of gunnery concentration were developed in 1917–18, while improved armour-piercing shells eventually reached the Grand Fleet in 1918. Goldrick is surely correct that these two developments would have proved decisive if there had been a fleet action in October 1918. However, gunnery developments in the German Navy after Jutland were not inconsiderable: by 1918, their aloft director could control elevation as well as training. As the war continued, both the British and Germans had increasing problems with the turbines of their older dreadnoughts. German machinery, especially condensers, became unreliable due not only to metal shortages but also a want of competent engineers, who were regarded as second-class officers.

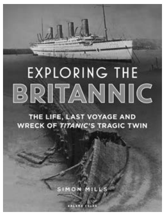
Running through the lucid accounts of major and minor operations are important common themes. On 19 August 1916 Scheer tried again to catch a portion of the Grand Fleet. He was able to position Zeppelins for reconnaissance and lines of submarines in the path of the expected British advance. Although the battle fleets did not make contact, his U-boats sank two British light cruisers; Jellicoe then concluded that it had become too dangerous to take the Grand Fleet regularly into the southern North Sea. Although Scheer planned further operations on similar lines – they were frustrated by bad weather – he was already urging an unrestricted submarine campaign, which began in February 1917. Goldrick describes this as a fundamental, and unnecessary error: by December 1916 the Allies were already losing 300,000 tons of shipping per month to U-boats operating under prize rules.

As shipping losses mounted, convoys were introduced in stages between July 1916 and April the following year. However, escorted convoys on fixed routes were attractive targets. On 17 October and 12 December 1917 German ships sank almost all the merchantmen and escorting destroyers in two Scandinavian convoys, disasters which led Beatty to cover many such convoys with squadrons of capital ships and then later with close escort by an expendable armoured cruiser. Mining was another menace to the operations of both sides, especially after 1917 when the British brought the effective H.II mine (based on the German mine with Hertz horns) into quantity production. It made possible a concerted effort to close the U-boat routes in and out of the Heligoland Bight and Flanders. This forced the Germans to increase greatly their minesweeping efforts, which in turn became the objective of British operations, notably that of 17 November 1917. This, however, was marred by poor staff work which, Goldrick argues, was more the fault of the Grand Fleet than the Admiralty. After the failure of earlier mine barrages, the deep Dover Barrage at last proved an effective U-boat barrier. Problems remained in night fighting that had been first apparent at Jutland. Goldrick identifies a number of what would later be seen as staff duties that were not well conducted, including the analysis of actions and dissemination of lessons learned; and identifying and procuring certain urgently needed material, notably mines and star shell.

In naval aviation the Germans pioneered the dropping of torpedoes and mines from aircraft, though apparently not to any lasting effect. A stimulus for British efforts was the need to launch fighters at sea to intercept Zeppelins. By 1918, almost every major unit carried such planes, as did lighters towed by destroyers, both types being successful. Work began in 1916 on the world's first flat-decked aircraft carrier, *Argus*, and the Sopwith T1 (the Cuckoo) was designed to carry an 18in torpedo. Could these developments, as Goldrick asks, have been pursued more aggressively? Given the inevitable design delays and conflicting procurement priorities, this seems unlikely.

Like its predecessor, *After Jutland* is based on deep research into original sources. Goldrick's themes, not least the successes and failures of staff work, will surely be a stimulus to further research.

John Brooks



Simon Mills

Exploring the *Britannic*: the life, last voyage and wreck of *Titanic*'s tragic twin

Adlard Coles, London 2019; hardback,
272 pages, illustrated with numerous
photographs, plans and paintings in colour
and B&W; price £25.00.
ISBN 978-1-4729-5492-3

This handsomely-produced volume is in many ways two books in one, and tells the full tale of *Britannic*'s century-plus of existence, at first, all-too-briefly, as a fully-functioning ship, and then as a particularly notable wreck on the bottom of the Aegean. In so doing it sheds much light on the issues that surround the whole field of wrecks: ownership, preservation, exploration, access, salvage and safety. As well as being a diver and professional cameraman with a long and successful career in film and television the author has, since 1996, been the legal owner of the wreck. On the evidence here, he happens to be rather a good writer as well.

The first of the book's two distinct parts recounts *Britannic*'s conception, construction, brief career, and dramatic demise. There is a short but interesting account of the structural issues that affected the class during design and build. These were highlighted by the loss of *Titanic* but they were really mainly a product of the liners' sheer size, for the three ships were without doubt stretching the limits of shipbuilding techniques in the early 20th century. This section is illustrated with a number of details from the original Harland and Wolff plans, unfortunately not always reproduced as large as they might have been – a particular pity as they are presented using the currently fashionable gatefold format. There is also a photograph of the ship on pages 34–35 that will be especially intriguing for *Warship* readers, but to disclose more here would be quite unfair…

The account of *Britannic*'s wartime career, based on a mix of official records and personal diaries and correspondence, sheds some fascinating light on both the requisitioning of passenger vessels for use as hospital ships and aspects of their subsequent operation. It also looks into the allegations of the ship being used for other purposes not compatible with her status, as well as her sinking after striking a German mine. Throughout, this section demonstrates Mills' thorough and wide-ranging approach to research.

The second half of the book picks up the story after nearly sixty years with the rediscovery of the wreck by Jacques Cousteau, the acquisition some twenty years later by the author of the rights to her ownership (something where he surely must have been a little less of a wide-eyed innocent than he depicts), and the ongoing programme of exploration that has taken place ever since. The tone here is entirely different, much of the story being effectively semi-autobiographical, and the book's designer has cleverly opted for a subtly different look to emphasise this change. Indeed, it should be noted that the book is particularly well designed throughout, with an eye-catching look that will give it appeal to the more general reader without ever sinking into graphical gimmickry. The story Mills tells is one that includes the inevitable diplomacy and bureaucracy that accompanies such international endeavours, as well as the challenges and risks involved in diving on a massive shipwreck in order to solve some of the mysteries that surround it. The aforementioned structural issues make a reappearance here, as the reasons for the liner's sinking and the extensive damage to the forward hull are examined, and there is also an unusual look at both the effect of the marine environment on her fabric and, conversely, of her impact on said environment (the latter surprisingly positive).

Over the course of a series of expeditions to the wreck Mills takes the reader into the fields of sourcing funding, negotiating television rights, the impact of the weather, technical issues and diving safety. Sad to relate, the latter eventually ends up in tragedy – a reminder that even in this high-tech age the sea remains as dangerous as it was a hundred years ago. This makes for a thoroughly sobering conclusion to a fine, unusual read, engagingly written and superbly illustrated throughout. Definitely recommended.

Stephen Dent

Zvonimir Freivogel

Austro-Hungarian Cruisers in World War One

Despot Infinitus, Zagreb 2017; softback, 272 pages,
many photographs and line drawings; price €39.90.
ISBN 978-953-7892-85-2

Austro-Hungarian Battleships in World War One

Despot Infinitus, Zagreb 2018; softback, 243 pages,
many photographs and line drawings; price €39.90.
ISBN 978-953-8218-15-6

Few English-language books have been published on the ships of the Austro-Hungarian Navy, so these two volumes on the cruisers and battleships, by an occasional *Warship* contributor, are to be welcomed.

Both follow the same format, with an introduction outlining the origins of each design, a detailed account of the characteristics, a service history of each of the ships in the class, a data table and a block of photographs interspersed with profile and plan views and plans (or line drawings) of key items of equipment such as gun turrets.

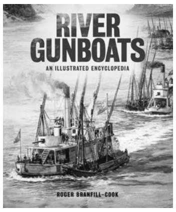
The photographs are outstanding and the data comprehensive. The images of the Austro-Hungarian ships, which have been collected by a variety of prominent A-H enthusiasts over the years, are complemented by photographs of similar ships of other navies and photographs of some superb models. The line drawings, by Erwin Sieche (cruisers and some battleships) are of a high standard, and the drawings of the battleships by the Croatian illustrators Danijel Frka and Zeljko Prša are stunning. Both books deal not only with the ships which entered service, but with the plans for their unbuilt successors.

The printing is on thick, quality paper which shows off the photos and line drawings to best effect. The layouts are traditional, with the text and illustration in separate blocks and two photos per page. However, the modern sans serif typeface is not a good fit with the dated punctuation, which features multiple points (S.M.S.) and German-style speech marks. One curious feature is that gun calibres are given in metric in the text and tables but in imperial in the captions.

The manuscript would have benefited from pre-editing by an English native speaker. The technical terminology (‘commando bridge’ apart) is generally acceptable, but constant inappropriate use of the present and past continuous tenses (‘the ships were having two funnels’) becomes irritating after a while. Also, although the author is clearly very knowledgeable about the Austro-Hungarian vessels, there are a number of conspicuous errors when discussing other navies. The *Entente Cordiale* was not an alliance, and certainly not in place as early as 1900 (*Battleships* p 153). On page 82 of the cruiser book the upper photo is of the former French cruiser *D’Entrecasteaux*, not *Dupuy de Lôme*, while the lower photo depicts an armoured cruiser of the *Gueydon*, not the *Gloire* class. Also, Delaunay-Belleville – not ‘Delauney’ – was a French, not a British company (p 96).

These errors detract from what is otherwise an outstanding pair of publications. Readers with a previous interest in the Austro-Hungarian Navy and those interested in finding out more about these much-neglected ships will find them an invaluable resource.

John Jordan



Roger Branfill-Cook
River Gunboats: An Illustrated Encyclopaedia.

Seaforth Publishing, Barnsley 2018;
hardback, 336 pages, 900 illustrations
including 45 in full colour; price £40.00.
ISBN 978-1-8483-2368-20

In this illustrated encyclopaedia the author has attempted to catalogue every river gunboat put into service by all known users since the introduction of steam in the mid-1850s. The layout is a little like an early copy of *Jane’s Fighting Ships*, but with a narrative interwoven with the specifications and drawings.

The book is divided into 56 chapters each assigned to a particular country prefaced by an introduction with notes and acknowledgements, with a bibliography, appendices and index at the end. Each chapter follows roughly the same format with in-depth information and illustrations supplied by the author, although the opening chapter, on an ephemeral country called Acre (now part of Brazil), is limited to two simple paragraphs of text. Many of the vessels are illustrated with photographs and plans or, where these are not available, line drawings or copies of paintings and prints. In all there are 612 photos, 224 plans and 55 other illustrations. The 45 colour illustrations are to be found later in two appendices dealing with vessels in popular culture and camouflage schemes respectively.

Having been commissioned to carry out a survey of the gunboat *Melik* some years ago, the reviewer has first-hand experience of Khartoum and the two Niles there, and is therefore able to offer detailed comment on the Egypt section, which seems comprehensive and accurate. The narrative covers the events from General Gordon’s assignment as Governor General of the Sudan up to the battle of Omdurman and the final defeat of the Mahdists by forces under General Kitchener, and the parts played by various gunboats. The difficulties of navigating the Nile cataracts and the floating weeds of the Sudd are mentioned, as are the frequent losses from grounding in addition to the war casualties. However, it is difficult to navigate between caption, quotation and text, especially where photos have apparently been placed to fit the page layout rather than following the sequence of the text. For example, a captioned drawing of a 12pdr gun from the *Melik* is sandwiched between a single truncated line of text from the previous page and the specifications of the *El Zafir* class. There is a vast vast amount of information assembled here, but it is not always employed to best effect.

For anyone with any interest in the gunboat as a concept, or in river campaigning in general, this book will be invaluable. The collection of so much information in one place is clearly the result of well-directed research over many years on the part of the author. The reviewer is looking forward to digging into the more obscure entries with pleasure!

W B Davies

Zvonimir Freivogel and Achille Rastelli
Adriatic Naval War 1940–1945

Despot Infinitus, Zagreb 2015; softback, 551 pages,
433 photographs and drawings; price €39.90.
ISBN 978-953-7892-44-9

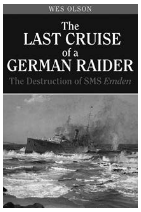
Of the various theatres of the war at sea in both World Wars, the Adriatic is certainly the least well-known, with none of the major actions of the kind seen in the Atlantic, Pacific and Mediterranean; its best-known episode is perhaps the 1918 sinking of the Austro-Hungarian battleship *Szent István* in 1918. However, in both conflicts there were intensive activities by smaller vessels, which are the principal actors in this ground-breaking study. As Zvonimir Freivogel sets out in his Foreword, this book has been a long time in gestation, and suffered the grievous blow of the death of Signor Rastelli in 2012, which ended hopes of a planned Italian version. The English version to hand is an expanded version of one published in Croatia in 2014.

An Introduction sets the scene in the Adriatic in 1940, looking backwards to the genesis of the Yugoslav Navy after the First World War and towards the situation which led to the Axis attack on Yugoslavia in April 1941. Chapter 1 then focuses on Italy between its declaration of war on the UK and France in June 1940 and the key month of April 1941, and Chapter 2 on the state of the Yugoslav Navy in that month; both chapters consider the full range of ships (naval and merchant) and infrastructures. Chapter 3 looks at naval activity in the Adriatic during the period leading up to the attack on Yugoslavia. Successive chapters then deal with the chronology and particular themes of activity in the theatre up until the end of the war. The final two chapters have an account of the Allied bombing of Adriatic ports during 1943/45, and an evaluation of each of the naval forces that participated in operations in the theatre. A final set of ten 'Attachments' (*ie* appendices) list the vessels assigned to certain formations, German minelaying operations, naval ranks, naval guns and equivalences between Italian and Croatian/Slovenian geographical names; they are followed by an extensive bibliography. Tabulated data is also found in a number of chapters.

Large numbers of photographs are provided, supplemented by a few drawings, depicting many of the key vessels mentioned in the text, along with images of various events. While most are of good quality (and include both well-known and less familiar views), they suffer from having been printed on the same paper as the text, meaning that contrast and tone are often sub-optimal.

As a comprehensive work on a subject hitherto little covered in English, this book is an extremely important addition to the literature on the naval (and wider) history of the Second World War. However, it has a number of significant issues. First, the text seems not to have been checked by a native English speaker: in most cases this merely leads to turns of phrase that annoy, but in some the exact meaning of a phrase or sentence is left partially or wholly obscure. Second, there are no maps, making it often impossible for anyone without an intimate knowledge of the Adriatic to follow parts of the narrative. Finally, there is no index, a wholly unacceptable omission in any serious work of history, especially one of over 500 pages. This is exacerbated by the vast cast of vessels that weave their way in and out of the narrative, sometimes under more than one name. This failure to provide even a basic index (the compilation of which would not have been that difficult a task using modern technology) significantly degrades the utility of this volume; the printing of all ship and boat names in bold, making it easier to locate them, cannot make up for this fundamental problem.

Aidan Dodson



Wes Olsen
The Last Cruise of a German Raider: The Destruction of SMS *Emden*

Seaforth Publishing, Barnsley 2018; hardback,
274 pages, numerous B&W illustrations;
price £25.00.
ISBN 978-15267-3729-8

Most of the books published to commemorate the centenary of the First World War at sea have revisited the Battle of Jutland, while other key naval campaigns have generally been neglected. It is therefore refreshing to read Wes Olsen's account of a less well-known course of events which took place across the vast and empty wastes of the Eastern Indian Ocean in the early days of the conflict. *The Last Cruise of a German Raider* is a graphic account of life aboard SMS *Emden* in the last three months of the light cruiser's existence. It follows her voyage from the German naval base at Tsingtao in Northern China to her eventual grounding on North Keeling in the Cocos Islands group. However, this is also a story of courage, endurance, dedication to duty and above all humanity in the last days before the world became consumed with the notion of 'total war'.

Olsen's narrative draws extensively on first-hand accounts principally by members of the crews of SMS *Emden* and her opponent in the battle at Cocos, the Australian cruiser *Sydney*. These take the form of letters, diaries, memoirs and survivor statements as well as some truly 'stomach-churning' reports by *Sydney's* surgeons who worked assiduously on the wounded of the two ships, sometimes in appalling conditions. Armed with these accounts, together with an intricate knowledge of the layout and workings of both warships, the author is able to present a vivid reconstruction of *Emden's* highly successful operations on the trade routes across the Indian Ocean before the fateful decision was made to attack the communications 'hub' on the Cocos Islands.

Following a brief foray into the Pacific, the *Emden* commenced her series of interceptions in early September 1914. Her commanding officer, Fregattenkapitän von Müller, undertook these attacks with a scrupulous adherence to the rules of war. Neutral merchantmen were permitted to proceed unaffected; those belonging to the Allied Powers were either sunk or commandeered if their cargoes, especially coal, were of use. However, the ships' crews of these vessels were invariably treated with care and respect; on more than one occasion this courtesy prompted a round of applause from the grateful sailors when they departed from *Emden*.

It is the thoughtfulness and care for human life that makes the long and detailed description of the destruction of the German cruiser particularly painful and difficult reading. The writer's use of the eye-witness statements brings startlingly to life the horrific destruction wrought by the 6in shells that rained down on *Emden* on that November day. The suffering carried on long after the German cruiser was beached and surrendered as the wounded, some of whom had struggled ashore, waited interminably for medical aid. Later, the job of the working parties from HMAS *Sydney*, tasked with clearing bloated corpses and body parts which had lain exposed to the tropical sun, simply defies belief.

The Last Cruise of a German Raider is excellent in every way. It has been meticulously researched, the author has a commanding knowledge of the technical aspects of his subject and he writes in a refreshingly unassuming manner. This is a book which will live long in the memory.

Jon Wise

Erminio Bagnasco

Submarines of World War Two: Design, Development and Operations

Seaforth Publishing, Barnsley 2018; 288 pages,
535 photographs, drawings and maps; price £40.00.
ISBN 978-1-5267-4453-1

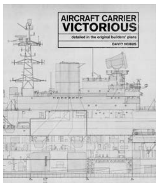
This is a new edition of a classic book first published in Italy in 1973, and published in English translation by Arms & Armour Press in 1977, with a paperback reprint in 2000. Beginning with an Introduction, which covers the history of the submarine up to the Second World War and an overview of its activities during that conflict, the book then covers individual nations one-by-one. The entries follow a uniform format, arranged by class, with a data table, an acount of development and a brief overview of careers. Building dates are given in broad-brush terms, with the start and completion years of the first unit of the class, and the completion year of the last. Fates are given in highly summary form, noting simply the year, theatre of loss (where relevant) and a letter-based indication of cause. The latter is somewhat unsatisfactory, as some codes group together a range of unrelated causes that could surely have been subdivided into additional categories.

The book is extensively illustrated: for most classes there is a range of photographs, together with profile and, in some cases, sectional line drawings. There are also drawings illustrating various technical matters, together with graphs and maps. While the labelling for most of the drawings is in English, the book's origins are occasionally betrayed by residual Italian annotations. There are also tables of various kinds of data; for some reason, older submarines in Soviet service are relegated to a single table, whereas in other navies all boats in service during the Second World War are accorded substantive entries.

As with other former Arms & Armour publications, the book has been entirely re-set by Seaforth, with an almost completely new set of photographs although, surprisingly, none of these are credited. While the images are almost universally splendid and reproduction is markedly better than in the original editions, a number of interesting and unusual photographs from the latter have been lost. It is also disappointing to find that the text has undergone only very minor changes since 1977, with the fates of a couple of long-surviving boats updated. The new edition thus takes no account of research into submarines over the past four decades, with nothing done to incorporate the considerable additional information made available since the 1990s regarding Soviet vessels. The bibliography is likewise unchanged from the original, and therefore takes no account of the many excellent submarine studies which have been published since 1977.

Accordingly, while still a fine source-book for anyone interested in submarines of the Second World War, and enhanced by the production values of the new design, this volume strikes the reviewer as something of a missed opportunity. While a comprehensive revision may have been beyond the scope of the project, something a little more could have been done to reflect ongoing research in some areas, and the failure to update the bibliography is difficult to forgive.

Aidan Dodson



David Hobbs

Aircraft Carrier *Victorious*: detailed in the original builders' plans

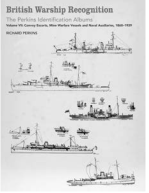
Seaforth Publishing in association with the
National Maritime Museum, 2018; hardback,
160 pages, complete sets of full colour plans; price £30.00.
ISBN 978-1-5267-3734-2

The third of a new series by Seaforth drawing on the collection of original plans held by the National Maritime Museum – the first two books were reviewed in *Warship 2019* – this volume focuses on HMS *Victorious*, one of a series of 'armoured carriers' laid down during the late 1930s and the only ship of her class to undergo a complete modernisation post-war.

The format is similar to the earlier two books, with full-length as-fitted profile and deck plans, including two 4-page gatefolds with the ship's profile from 1941 and profile and flight deck plans from 1958, plus enlarged profile, sections and deck plans, all comprehensively annotated by the author. Given the large size of the ship, the original labelling is not always legible, particularly on the larger plans. This is a particular problem in the case of the DNC armour 'concept' plan from 1936 reproduced in the Introduction, and given that protection was a key aspect of these ships, this has to be a negative. However, the gatefold plans and the enlargements more than compensate for this, and those which depict the ship post-modernisation are beautifully drawn and reproduced with exceptional clarity.

One of the undoubted strengths of the book is the quality of information provided in the annotations by the author. David Hobbs served as a midshipman on board *Victorious* post-modernisation, and is therefore in a position to describe elements of the re-design in terms of their *rational*e and function, and also to highlight aspects of life on board, not least of which was the level of noise transmitted to the accommodation spaces below the flight and hangar decks during air operations when at sea.

John Jordan



British Warship Recognition

The Perkins Identification Albums

Volume VII: Convoy Escorts, Mine Warfare Vessels and Naval Auxiliaries, 1860–1939

RICHARD PERKINS

Richard Perkins (with introduction by Andrew Choong)

British Warship Recognition: Volume VII: Convoy Escorts, Mine Warfare Vessels and Naval Auxiliaries, 1860–1939

Seaforth Publishing, in association with the National Maritime Museum, 2018; large format hardback, 256 pages, illustrated in full colour throughout; price £70.00.
ISBN 978-1-5267-3738-0

The final volume of this remarkable series is another hefty affair, with a price to match. It is also, perhaps inevitably, the least immediately attractive sounding of the titles, dealing as it does with a large number of rather unglamorous ships that served with the Royal and Dominion Navies during the period.

While the bulk of the series has followed Perkins' original arrangement, there have been exceptions where it has made sense to re-order things somewhat. This book is one such, for it actually contains a mixture of material from three of the original volumes, with the final part of Volume VI (convoy escorts of assorted types, and minesweepers), and then the whole of Volumes VII and VIII (all manner of minor vessels, harbour craft and auxiliaries). Thus the reader is presented with a huge range of vessels, including sloops from the WWI-era 'Flower' class through to the immediately pre-WWII *Bittern*s, minesweepers, survey ships, converted minelayers, depot ships, tugs, dredgers, assorted lighters (powered and un-powered), coaling hulks, launches, sailing barges, RNVR drill ships, and so on. The drawings are accompanied by a number of extensive tables of class differences, disposition of ships, and so on.

Coverage is sometimes patchy, especially in the original Volume VIII, where Perkins also introduced a new system of symbols which he left unexplained (a suggested interpretation by the NMM is offered here). While perhaps this might reflect a lessening of enthusiasm on the part of the author, it does seem out of character and therefore rather unlikely, and a more plausible reason is that it is simply the result of information on, for example, stores lighters being rather more scarce than that for battleships. In contrast it looks like Perkins was something of a tug buff, and the section devoted to these ubiquitous, important and often much-loved vessels contains some of the best, most colourful and most carefully realised of all his recognition drawings.

As with Volume IV, we get a single, unexplained, reproduction of a newspaper cutting, in this instance from the *Western Morning News*, showing a redundant powder hulk being towed under Brunel's Tamar bridge on her way to the breakers, and also a single photograph of a late Victorian gunboat. There are one or two rather random positionings of pages and, as with some earlier volumes, one section is reproduced a bit too faithfully, with some of the inter-war sloops being turned round 90° from the rest of the book, which makes reference awkward unless you have a large, reasonably clear desk.

However, to put these small criticisms into perspective, and give a couple of examples of the book's utility, the photographs of *Aurora* on page 39 of Norman Friedman's *British Cruisers* (Seaforth, 2010) can now be confirmed as having been taken at Devonport, due to the presence of the distinctive coal hulk *C.69* in the background, while the survey ship on page 197 of *Warship 2011* is definitely *Ormonde*, distinguishable from her three sister ships by various details of the ventilation cowls and funnel.

For anyone who has invested in the entire series (and probably had to re-arrange their library to accommodate it) this volume is certainly indispensable; for the rest, to be honest, it is a bit more debatable. Nevertheless, this book represents a fine conclusion to a series that reflects great credit on all those involved.

Stephen Dent

Marcus F Robinson and Gertrude J Robinson

Der Kapitän: U-Boat Ace Hans Rose

Amberley Publishing, 2018; hardback, 320 pages,
89 illustrations of which 13 in full colour; price £20.00.
ISBN 978-1-4456-7560-2

This book, compiled by the authors from many sources, including surviving family, military records, diaries and autobiographical writings, is about the life of Hans Rose, one of the top submarine commanders of the First World War while in command of *U-53*, who then somehow came to terms with serving in a senior position during the Second World War.

The authors have made every effort to fill in the gaps in Rose's own writings. This breadth of research is commendable but sometimes makes the book a difficult read, as the insertion of quotes, military reports and jottings breaks up the flow of the narrative. However, it is worth the effort, as the reader will be rewarded with a valuable insight into the mentality of the German officer classes during the build-up to the Second World War. There will have been other senior officers in the German armed forces who flirted with the Nazi party or the SA, but who ultimately accepted the Nazi regime with fewer reservations than did Hans Rose.

The 25 chapters cover Rose's career during the Great War in some detail before moving on to the interwar period and his return to service during the Second World War. Retirement in 1943 following the death of his wife marked the start of a readjustment to civilian life and to the conditions found in Germany during the late-war and immediate postwar periods.

Near the end of the book is a brief description of Rose's WWI U-boat, *U-53*. One of the things that stands out is the comparatively comfortable conditions in these early boats compared to those of the later war. The patrols were generally shorter – although Rose demonstrated that the boats were capable of transatlantic crossings – and the crews were smaller in number. Most of the patrols were carried out on the surface, and time was available for fishing and recreation. The introduction of the convoy system, ASDIC and air patrols ensured that these conditions were not replicated in the Second World War.

This is a fascinating insight into the mind of a German officer who firmly believed in his persona as a knight of the German race, skilled in his chosen role, but equally chivalrous to his defeated foes. Rose initially managed to carry this attitude through when he re-joined the navy at the start of the Second World War, but his views changed as the nature of the Nazi regime and the destruction of Germany became more and more apparent.

W B Davies

Zvonimir Freivogel
The Battle of Lissa 1866

Despot Infinitus, Zagreb, 2017; paperback, 148 pages,
heavily illustrated; price €29.90.
ISBN 078-953-7892-46-4

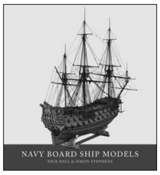
The naval battle off the Adriatic island of Lissa pitted the fleet of a newly and incompletely unified Italy against the smaller force of the Austrian Empire, as part of wider war in which Prussia defeated Austria, but Austria defeated Italy. The battle followed an Italian attempt to capture Lissa to compensate for a heavy defeat on land. The Italian Admiral Persano, burdened with two tasks, seizing territory and fighting a battle, was unenthusiastic about his mission. The attack on the island was proceeding slowly when the Austrian fleet, led by Rear Admiral Wilhelm Tegetthoff, appeared. The Austrian had only one mission: to defeat the enemy in battle. When Persano stopped his flagship to transfer to another ship he forgot to take the command flag with him. As a result the Italians ignored his orders, and a large gap opened in the Italian formation. Tegetthoff spotted the opening and charged, using an arrowhead formation, led by his most powerful ironclads. After a series of clashes between individual ships Tegetthoff encountered the disabled and stationary *Re d'Italia*, which he rammed in his flagship *Ferdinand Max*; the American-built, wooden hulled Italian ship sank with heavy loss of life. Another Italian ironclad, the *Palestro*, caught fire and blew up. Freivogel reports that both ships, along with the Austrian frigate *Radetzky*, which sank in 1869, have been located and dived, fixing the location of the action.

Freivogel claims that Lissa secured Austrian control of the eastern shores of the Adriatic for another fifty years, and that two-thirds of the Austrian crews were of Croatian origin. He also explores the fate of the fabulous lion monument erected on Lissa to commemorate the victory. In 1918 the island was seized by Italy, and the monument was taken to the Italian Naval Academy in Livorno, where it stands in the courtyard with additional text bolted on which celebrates Italy's victory over Austria-Hungary of November 1918: hardly the most uplifting prospect for new cadets …

Elsewhere Tegetthoff, then in his 40s, became an international celebrity, but died a mere five years later, while the Habsburg naval budget fell sharply. Navies around the world became obsessed by the ram, which became a staple of naval design, despite the uniquely favourable circumstances in which it had been successful. The proliferation of beaked prows led to several losses in collisions, the most famous being HMS *Victoria* 30 years later.

The book comprises a detailed description of the ships, the politics and the action (to the extent that a smoke-shrouded melee can ever be analysed), and is packed with illustrations. The layout is highly unusual, with the margin of each page carrying a graphic, along with a header that echoes the watermarks of hand-laid paper. The quality of the images is compromised by the use of a matt light grey paper. The book would have profited from an English editor and access to Lawrence Sondhaus' important study of 1989, *The Habsburg Empire and the Sea: Austrian Naval Policy 1797–1866*. Students of the battle would also profit from Agnes Husslein-Arco's study of the artist Anton Romako from 2010, which not only examines his powerful image of Tegetthoff at the climax of the battle, but also the wider artistic response, as well as printing the best contemporary photographs in high definition. In sum, this is a fresh and stimulating text that adds important evidence to the subject, even if it falls short of a comprehensive treatment.

Andrew Lambert



Nick Ball & Simon Stephens
Navy Board Ship Models

Seaforth Publishing (in association with Royal
Museums Greenwich), Barnsley 2018;
hardback, 248 pages, illustrated with colour
photographs throughout; price £40.00.
ISBN 978-15267-0111-4

The current trend among curators has led to far fewer ship models being displayed in maritime museums, meaning that large-scale, highly accurate models, which constitute an essential and visually arresting part of our maritime heritage, are often left to languish in hidden storerooms. Fortunately, the importance of the 54 so-called 'Navy Board Models' owned by the Royal Museums, Greenwich, is recognised and they are made accessible to the public. These rare and exquisite models, dating from the 1650s through to 1775, are truly the 'crown jewels' of their kind. Ball and Stephens' large format *Navy Board Ship Models* describes the collection in great detail with the aid of some stunning colour photographs.

The book is divided into three sections which give in turn the historical background, analyses of the unique construction methods used, and an annotated catalogue of the surviving models in the Greenwich collection. The authors relate how, from their inception, the ship models have been highly desirable and prized objects, owned by royalty and various wealthy gentlemen of the time such as Samuel Pepys. While much earlier research has tended to focus on the ships the models represented, in contrast this book concentrates on the models themselves and their unique construction style, which sets them apart from their modern equivalents.

Unquestionably, the Navy Board models required a huge amount of time, dedication and skill to construct. Indeed, the authors speculate that it could have taken several years to build one model, given the nature of the intricate and ornate designs. However, remarkably, there is very little written evidence to explain quite why they were made in the first place and indeed whether the term 'Navy Board Models' is appropriate. It is doubtful whether they would have been useful to the Admiralty when paper drafts (also confusingly referred to at the time as 'models') were available and could be much more easily altered or adapted at the design stage. The distinctive feature of a Navy Board model is the exposure of part or all of the ship's framing. However, this stylised simplification of a ship's hull, although aesthetically pleasing, would not have been of practical use and indeed frequently differed from the ultimate configuration.

Aside from discussing these conundrums, a substantial two thirds of the book is the 'Catalogue', which provides an excellent insight into all 54 models. By way of example, *Ajax*, a 74-gun Third Rate is described across two pages in terms of its construction and the materials used, its fixtures, fittings and decoration. One of the large photographs illustrates the way in which the model has been constructed to separate horizontally so as to demonstrate the complex internal layout of the lower decks and hull. Much of the hull and decks show the framing only, while the masts and rigging are absent altogether. However, the highly decorated galleried stern is shown in its completed state, a stunning example of the skill of the modeller.

This is a very high quality publication matched by a hefty price tag. However, if the publisher had skimped on their production costs the book would not have done justice to its subject matter in the way it has.

Jon Wise

Nicholas Jellicoe
The Last Days of the High Seas Fleet. From Mutiny to Scapa Flow

Seaforth Publishing, 2019; hardback, 351 pages, 7 colour and 30 B&W illustrations; price £25.
ISBN 978-1-5267-5458-5

David Meara
The Great Scuttle: The End of the German High Seas Fleet: Witnessing History

Amberley Publishing, 2019; paperback, 96 pages, 40 colour and 60 B&W illustrations; price £14.99.
ISBN 978-1-4456-8700-1

These two books commemorate the scuttling of the German ships interned in Scapa Flow on 21 June 1919. The decline of the High Seas Fleet began with the disaffection of its crews in 1917 and continued with the outright mutinies of 1918 that led to the collapse of the Imperial government and the signing of the Armistice. Under its terms, the German Navy's more modern surface ships would be interned in Scapa Flow until their disposal was settled by the peace treaty. Stripped of ammunition and essential gunnery equipment and under the command of Rear Admiral Ludwig von Reuter, they were to sail first to Rosyth for inspection; their arrival in the presence of the whole Grand Fleet was staged by Admiral Sir David Beatty to appear as an abject surrender. Once anchored in the Flow, the interned ships were supervised by the British squadron also based there. By April 1919, this was the 1st Battle Squadron commanded by Vice Admiral Sir Sydney Fremantle under the C-in-C of the recently-formed Atlantic Fleet, Admiral Sir Charles Madden. However, by the terms of the internment, no guards could be placed aboard the German ships.

On 7 May 1919 in Paris, the German delegation was handed the terms of the Peace Treaty. All the interned ships were to be surrendered, though the Allies could not agree on whether the ships should then be sunk or distributed among them. The deadline for signing was 21 June when the Armistice expired; if the Germans refused, hostilities would recommence. As von Reuter, Madden and Fremantle all recognised, whether the Germans signed or not, their defenceless ships must be seized and the only way to prevent this would be to sink them. On 17 June, von Reuter issued his detailed orders for the scuttling.

Fearing German intentions, Fremantle developed plans, which were approved by Madden on the 19th, for seizing the German ships on the night of 21/22 June. However, on the 20th, the German government resigned and a new signing deadline of 23 June was set. Despite Fremantle's objections, Madden now ordered the 1st Battle Squadron to go to sea on 21 June for torpedo exercises, while the date for seizure was put back to the 23rd. Shortly after the British squadron left the Flow, von Reuter hoisted the preparatory signal for the scuttle; it was an almost complete success.

The scuttling largely resolved the Allies' disagreement, though the Germans were required to make up some of the losses in light cruisers and destroyers. By the time of the Washington Conference in 1921, the High Seas Fleet no longer existed but the wrecks still remained in Scapa Flow. Salvage began in 1924 and, thanks mainly to the heroic work of Ernest Cox and his workers, by 1931 six capital ships, *Bremse* and 26 destroyers had been raised, although Cox, who had spent £450,000, made a small loss of about £10,000. The salvage was continued more profitably by Metal Industries until 1939. Today, three battleships, *Baden's* turrets and four light cruisers still lie on the bottom of the Flow.

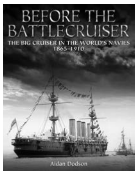
Nicholas Jellicoe's book covers all these topics in detail, although regrettably without a chart of the fleet anchorage. Given his title, the chapter on the Washington Conference seems superfluous; a chapter on the ships of the High Seas Fleet that were not interned, or were refloated, would have been preferable. Meara's short book is limited to the 'surrender' at Rosyth, the scuttle and the salvage, but benefits from many well-chosen illustrations including useful charts. The scuttle was observed by a party of Orcadian schoolchildren on a trip around the interned fleet aboard the tug *Flying Kestrel*. Both authors draw on their vivid recollections, though many were not recorded until long after the event.

Jellicoe acknowledges that eyewitness accounts are often contradictory, though neither book attempts to distinguish between more and less reliable sources.

Von Reuter's orders stipulated that all the boats used in abandoning ship should be provided with white flags of truce. However, the British vessels trying to prevent the scuttle fired on German boats in unsuccessful attempts to drive the Germans back to their ships: though some shooting may have been deliberately wide or intended only to sever anchor chains. Nonetheless, eight Germans were killed that day. A worrying case was that of the commanding officer of *Markgraf* who, though carrying a white flag, was shot in the head by a Lieutenant Turner from the drifter *Cabalsin*. Yet neither book asks whether Turner was held accountable.

Jellicoe concludes that Madden's order for torpedo practice was 'nothing short of extraordinary' and that the scuttle was 'extremely convenient'. But had the British connived at the outcome? The immediate reaction of Admiral Wemyss (First Sea Lord) does not read as though he had any prior knowledge. Fremantle had objected to the practice order; before he sailed, he had learned unofficially – not from Madden – that the treaty signing had been postponed, though he probably did not inform von Reuter. As for Madden, according to Marder he had spearheaded a campaign within the Navy for the surrendered German ships to be allocated, to Britain's advantage, among the Allies. On balance it seems that neither was guilty of subterfuge. But they certainly failed to recognise that, whatever von Reuter knew, he could not be relied upon to delay the scuttle until the 23rd.

John Brooks



Aidan Dodson
Before the Battlecruiser

Seaforth Publishing, Barnsley 2019; hardback, 304 pages, illustrated with line drawings and B&W photographs plus eight pages of full colour plans; price £35.00.
ISBN 978-1-4738-9216-3

This latest work from a regular *Warship* contributor is subtitled 'The big cruiser in the world's navies, 1865–1910', and is effectively two books in one. Split neatly in half, the first consists of a wide-ranging history of the many ships which, in the author's view, formed the precursors to the famous battlecruisers of the Great War era; the second of detailed data tables, summarised career histories, and appearance/arrangement drawings. The primary stated purpose of this latter is to present a comprehensive and accurate record, since many established sources are out of date, contradictory, or in error.

Dodson interprets the term 'big cruiser' pretty loosely, with the result that as well as the expected armoured cruisers and large protected cruisers there are numerous smaller examples of the type, as well as assorted ironclads, coast defence ships and even a few pre-dreadnought battleships, including the British *Renown*, the American *Maine* and the Russian *Oslyabya*. If nothing else this certainly shows a distinct reluctance to be tied by conventional nomenclature. He makes clear his view that armoured cruisers in particular have been unfairly treated by history, perhaps best exemplified by the loss of the three British vessels at Jutland where, he points out, two were sunk in circumstances which would probably have done for much more modern, powerful units, while the third actually survived very heavy punishment indeed before sinking.

An outstanding feature of the book is the selection of photographs. As well as from the author's own evidently very extensive collection these also come from a wide variety of sources, including more than a few that one would not necessarily think of when looking for warship pictures. That said, it could also be argued that not all are reproduced as large as one would ideally like, although that in turn would have resulted in a bigger, and hence more expensive, book.

Readers familiar with the Dodson's *Warship* articles will be aware that he has a particular interest in what happened to warships after the ends of their front-line careers. The ships covered here provide him with plenty of scope, as many served a very long time in all manner of roles, some as might be expected (training ships, accommodation hulks, minelayers) others rather less so (cargo vessel, repatriation ship, dummy to fool air reconnaissance). Quite a few survived the Second World War, the Argentinian *Pueyrredón* serving for over half a century while the last, Greece's *Averof*, remains afloat as a museum ship.

Given the sheer quantity of material assembled here it is a pity that there are so many lapses in editing, with more than a few instances of repetition, incomplete references, missing punctuation, and occasional bits that simply don't make sense. Some aspects of the typesetting and layout are likewise not as tight as they might be; on the other hand the book is well printed, on thick, good quality paper. This is an unusual, intriguing title, absolutely crammed full of little-known information.

Stephen Dent

Hans Lengerer and Lars Ahlberg
Armourclad *Fuso* to *Kongo* class Battlecruisers

Despot Infinitus, Zagreb 2019; hardback, 612 pages, 351 photographs, drawings and maps; price €89.90/$108.98.
ISBN 978-953-8218-26-2

The armoured ships – ironclads, battleships and battlecruisers – of major navies are in general well documented and the subject of authoritative books by established writers. Works by Beeler, Ballard and Parkes are consulted for the Victorian Royal Navy's capital ships, Raven and Roberts for later British ships, and Ray Burt and Norman Friedman's epic volumes for both periods; analogous publications cover French, Italian, Russian and American capital ships. Dirk Nottelmann's *Warship International* series deals with the Imperial German Navy's armoured ships and *Linienschiffe* to 1918. The Imperial Japanese Navy, however, presents known problems of language and limited documentation, and previous books on its big-gun capital ships have concentrated on the twelve Second World War battleships.

Lengerer and Ahlberg have compiled a large, heavy volume that takes a fresh look at the earlier ships. The structural framework comes from their illustration-free subscription-only on-line journal, *Contributions to the History of Imperial Japanese Warships* (17 issues, 2006 to date). As noted in the sub-title, this is the first volume of an Outline History of the Design, Construction and Operations of Capital Ships of the Imperial Japanese Navy 1868–1945; Volume 3 (*The* Yamato *class and Subsequent Planning*) was published by Nimble Books in 2014).

Volume 1 is an occasionally infuriating battleship book, with scant resemblance to the publications mentioned above in arrangement or layout. It starts with essays on Japanese domestic politics and the expeditions in the 1870s and 1880s to establish borders with Imperial China. Fearing encirclement, China built a substantial fleet, starting with gunboats and small cruisers and culminating in two large citadel ships. Japan, poorer and weaker, countered with the three *Sankeikan*, protected cruisers or coast defence ships each mounting a single large armour-piercing gun. The administration was unable to cajole or coerce successive Diets into voting the money for two first-class battleships until the Emperor intervened (1893). In the Sino-Japanese War (1894–95) Japan triumphed on land and sea; the reaction of France, Germany and Russia to the terms of the Treaty of Shimonoseki provided an abrupt introduction to Great Power politics. The indemnity from the war provided not only the fleet of four additional battleships and six armoured cruisers that trounced the Russian Navy in 1904–05 but also the Yawata Steel Works, Japan's first.

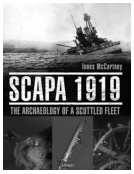
The authors begin with Reed's central battery *Fuso* – the four small early armoured ships *Azuma*, *Ryuho*, *Kongo* and *Hiei* are not described – and continue through the eight first-class battleships and two 'semi-dreadnoughts', all closely resembling White's and Watts' successive Royal Navy designs, to four large armoured cruisers (in effect pre-dreadnought battlecruisers) and Japan's first dreadnoughts. Coverage ends with the four battlecruisers of the *Kongo* class. The seven battleships captured from China and Russia are dealt with briefly.

The expected technical and operational details are set out in detail, but the book's structure means that the illustrations, which feel as if they have been added as an afterthought, are chaotically arranged. As an example, the photos of the first-class battleships are in three distinct sequences: the main section, the machinery trials section and the operational history section. Photos are duplicated. The line drawings, some folding and from a variety of sources, are often poor in quality and reproduction; in certain instances, notably *Fuji* and *Hatsuse*, the photos establish that they do not accurately represent the ship concerned. The *Asahi* plan and profile leaves out the centre of the ship, showing bow and stern only; a plan and elevation of *Katori* (page 130) is labelled *Kashima*.

The chapters on armament and machinery are well illustrated with diagrams, in contrast to the ship sections. The manufacture of wire-wound guns on the British pattern used in Japan before the *Yamato* is described and illustrated in detail; a standard 12in gun contained about 160km of wire, with 12 layers at the muzzle and 80 layers at the breech end.

The book is very expensive and unnecessarily spacious; its contents could be compressed into 400 pages without loss. The dedicated battleship enthusiast will probably want to look elsewhere for the definitive account of this most fascinating of subjects.

Ian Sturton



Innes McCartney
Scapa 1919: The Archaeology of a Scuttled Fleet

Osprey Publishing, Oxford, 2019; hardback, 336 pages, illustrated with photographs, maps and diagrams in colour and B&W; price £30.00.
ISBN 978-1-4728-2890-3

Effectively a sequel to McCartney's well-received *Jutland 1916* (Conway 2016, reviewed in *Warship 2017*), the first half of this handsomely produced book consists of a comprehensive re-telling of the protracted demise of the German High Seas fleet, from mutiny through internment, scuttling, salvage, scrapping and, finally, the scheduling as historic monuments of seven of the most substantial wrecks in 2002. The second, larger part is a detailed description of these survivals, as well as of a number of other, rather less well-known remnants of the events of June 1919. In addition there is a short but important introductory section describing the author's aims and methodology, the historical and archaeological context, and also a clear explanation of the impressive digital imaging that forms a central part of the book.

It is, inevitably, a rather less dramatic tale than that which surrounds the Jutland wrecks. There are fewer full-scale mysteries here, but there has been plenty to investigate all the same, a process which McCartney has gone about over the course of several years by way of archival research followed by extensive underwater archaeology in the form of sonar surveys and numerous dives (made feasible by the relative accessibility of the wreck sites). Although due acknowledgement is given to classic works such as Ruge's *Scapa Flow* (Ian Allan, 1973) and van der Vat's *The Grand Scuttle* (Hodder & Stoughton, 1982), McCartney makes clear that he has predominantly used primary sources in his research in an effort to clear up some of the ambiguities attached to the tale of the scuttling and subsequent events. One unexpected but significant by-product of this is the appearance in the book of a set of photographs of the scuttling held in the National Maritime Museum, which may never have been published before.

Each of the seven major surviving wrecks is described in detail. They appear at once both impressive and slightly sad, as their ongoing decay under the relentless twin forces of time and tide becomes evident. Unfortunately it seems that their popularity as recreational dive sites may be contributing to this, even if largely inadvertently. As with many archaeological reports there is a degree of repetition in the descriptions, which does sometimes make for a less than riveting read. The photographs that accompany this section are of variable quality, with some so indistinct that they could be of practically anything, while those taken by the late Gavin Anderson are sharp, clear and wonderfully evocative.

A surprising amount is left of ships other than the main wrecks, both in the locations of the original scuttling and the sites where the raised hulks were worked on by the salvagers. This includes masts, cranes, derricks, searchlights, guns, chunks of superstructure and, most impressively, all four 15in turrets from *Bayern*. McCartney quickly dismisses, on the grounds of cost, the notion that this might represent an opportunity for some 21st century salvage, not for scrap metal but for preservation and display. This seems a pity; he has a point, but these remains aren't going to be around for ever, and once they are gone that will be the end of the story.

McCartney writes in a matter-of-fact way, thorough, objective and with little ornamentation, though his great affection for the wrecks does become apparent. There is a departure from his usual measured manner when it comes to the sad business of the deaths of a small number of surrendering – or indeed surrendered – German sailors at the time: a rare sense of anger at ordinary seamen still left to pay the ultimate price for their leaders' cynical bickering elsewhere, even with the war by then many months over.

There are a few small errors (including the wrong date being given on the back cover!), some of the maps are too small to be of much use, and the editing could have been tighter. More thought could have gone into the layout, which frequently has the reader flipping back and forward between pages to match photographs to their accompanying narrative text, while sections of white text on black pages will not appeal to all. Nevertheless, overall this book is a fascinating read, as well as being very good value for money.

Stephen Dent

Stephen M Younger

Silver State Dreadnought: The Remarkable Story of the Battleship *Nevada*

Naval Institute Press, Annapolis 2018; hardback, 303 pages,
154 photographs; price $54.00.
ISBN 978-1-68247-289-7

USS *Nevada* was the first battleship to be built with 'all or nothing' protection. Her service life also lasted for over three decades. Her career therefore provides an excellent lens through which to view the US battle fleet during this era.

The US Navy was keen that the design process for Nevada should not repeat the errors of the first US all-big-gun battleships of the *South Carolina* class, which although laid down well before HMS *Dreadnought* were completed some years later than the revolutionary British ship, and without her advance in propulsion machinery. The US Navy was keen to take credit for the next conceptual leap forward in battleship design, albeit within the constraints of available funding. These two factors came together to drive *Nevada*'s novel protection system and the adoption of oil fuel, together with the first triple turrets to enter US service.

The author blames the 'dismal results' of the turbine installation in *Nevada*'s immediate predecessor *North Dakota* for the reversion to reciprocating engines in her sister *Oklahoma*, but fails to note that this was a matter of heavy fuel consumption rather than any technical shortfalls, and that the decision to fit turbines in *Nevada* (and all later) battleships was because the superior thermal efficiency of oil offset the higher consumption of direct-drive turbines. Interestingly, when *Nevada* was re-engined in 1928, she received geared turbines that had been fitted experimentally in *North Dakota* in 1917.

A detailed account of the building and trials of *Nevada* is followed by successive chapters relating her service career. Initially held back in home waters owing to a shortage of oil fuel in UK waters, *Nevada* and *Oklahoma* were deployed to Bantry Bay, on the Irish coast, in August 1918, to guard against any raids by German heavy ships on inbound transatlantic convoys. Post-war, *Nevada* served in both the Atlantic and Pacific fleets, and took part in the 1925 Great Cruise to Australasia, which is the subject of a number of interesting photographs.

Rebuilt during 1927/28, the ship, as well as having her machinery replaced, emerged with a very different appearance: the original cage masts were replaced by tripods and the secondary battery was moved to the upper deck. She returned to active service in 1930, spending almost all of the next decade in the Pacific, and was at Pearl Harbor on 7 December 1941. The only battleship able to get underway during the attack, *Nevada* was hit forward by an aerial torpedo, as well as by seven bombs, and had to be beached, with much of her superstructure burnt out.

She was refloated in February 1942 and, after initial repairs, sailed for Puget Sound in April, where she was extensively refitted, completing in December with a much-changed profile and armament. She then saw service in various theatres, being assigned to missions including Atlantic convoy escort (1943), shore bombardment off the Normandy beaches, the Mediterranean (1944), and Iwo Jima and Okinawa in 1945.

In late 1945 she became a target ship for atomic bomb trials at Bikini Atoll. She survived both explosions in July 1946, but was very heavily irradiated by the second of them. In dealing with this episode in the ship's career, the author's background as a nuclear weapons historian (a previous book being *The Bomb: A New History*) is apparent. He highlights the way in which personnel were thoughtlessly exposed to dangerous levels of radiation while attempting to decontaminate *Nevada* and other ships. Her radioactivity was such that she was fit only for sinking, which was achieved in July 1948, although the old ship only succumbed to aerial torpedoes after surviving both 16in and smaller gunfire.

There are a number of instances where the author demonstrates he is less comfortable when dealing with non-US ships and issues. Otherwise, this book is an excellent account of the history of an important ship, well-written and very well illustrated with a variety of photographs which cover almost every aspect of her career.

Aidan Dodson

William N Still Jr

Victory without Peace: The United States Navy in European Waters, 1919–1924

Naval Institute Press, Annapolis, Maryland 2018; hardback, 370 pages, illustrated with eight pages of B&W plates; price $68.00. ISBN 978-1-68247-014-5

This large format, impressively researched book recounts the operations of the USN in and around Europe in the years immediately after the First World War, a time when both the force and the country it served were attempting to come to terms with the new status of 'world power'. William Still's approach to a diverse subject is to treat it thematically, rather than strictly chronologically, although the final four chapters do provide a blow-by-blow account of events in and around the former Ottoman empire. The remainder of the book covers the Navy's part in the Paris peace conference, the problems associated with demobilisation, various relief and peace-keeping missions, and the removal of the North Sea mine barrage.

Throughout, Still is more interested in the higher levels of the exercise of naval power – the senior personalities and their policies and decision making – rather than the experiences of those lower down or the performances of the ships and systems that they operated. As an example, a large part of the Paris chapter consists of short pen-portraits of members of the US delegation. Here Still's desire to be as historically objective as possible results in a tendency to list in detail each individual's good and bad points, with the result that the narrative does rather drift. He is clearly an admirer of Sims and of Hoover, in particular for the latter's work on postwar famine relief; on the other hand, Roosevelt is painted as somewhat superficial and with a tendency to claim credit for the work of others. The US participants in the conference frequently noted their dismay at the petty nationalistic bickering of the delegates of other nations; however, they hardly seem to have been above such behaviour themselves, repeatedly disagreeing on political or personal grounds.

The chapter covering the disposal of the 'Pills of Perdition' – the Northern Barrage minefield – is much sharper, recounting the difficulties and dangers of what was then a quite unprecedented operation carried out in thoroughly inhospitable conditions, and using equipment that was often either novel, inadequate or poorly suited to the task. Based at an old herring packing plant at Kirkwall in Orkney, numerous ships were damaged and a few lost, and eleven men died. Nobody received extra pay for this; their British opposite numbers did.

Still has a slightly staccato style of writing, crammed full of facts, dates and short quotations, and the book is not an easy read. He is less interested in what it was actually like serving in a destroyer attempting to police an uneasy peace in the northern Adriatic than in the convoluted and often quite tetchy deliberations in Washington, Paris and elsewhere. He is clear in his admiration for admirals such as Mark Bristol, Philip Andrews and Newton McCully, tasked with implementing variously imprecise, contradictory or simply oft-changing orders, and doing their best with the forces they were given, sometimes with the help of their nominal allies, but frequently without. Rivalries with France, Britain and Italy (as well as between the three) coloured much of what occurred, as did the ongoing background of US domestic politics, seemingly as divided then as today.

The concluding section covers much of the same ground as Robert Schenk's *America's Black Sea Fleet* (reviewed in *Warship 2014*, 188–9), which contains a good deal of implicit criticism of Admiral Bristol, mainly for his prioritising of American commercial interests over other areas such as peace-keeping and humanitarian relief. Still takes a rather different and more favourable stance towards this controversial figure, pointing out numerous instances where he *did* facilitate humanitarian missions, and also emphasising the generally difficult conditions under which he and his command had to operate, with distinctly patchy support from Washington. This highlights a common thread throughout the book, namely the challenges of not only operating overseas, in an era of poor communications, but also in a locality commonly regarded as something of a backwater. A similar theme, though never explicitly stated, is the success that a naval presence, even the low-key one of a sub-chaser or two and a party of marines, had in terms of keeping the peace or, at worst, of preventing disputes escalating. The US Navy may not always have been that popular with its British and (particularly) French erstwhile allies, but thousands upon thousands of less-than-fortunate souls dotted around the margins of post-war Europe had a great deal to thank it for.

Stephen Dent

MARCO GHIGLINO
ITALIAN NAVAL CAMOUFLAGE OF WORLD WAR II

Marco Ghiglino

Italian Naval Camouflage of World War II

Seaforth Publishing, Barnsley 2018; hardback, 240 pages, several hundred colour drawings and numerous colour and B&W photographs; price £35.00. ISBN 978-1-5267-3539-3

Italian Naval Camouflage of World War II is the first detailed English-language study of the *Regia Marina's* use of camouflage during the Second World War. Building on Erminio Bagnasco's and Maurizio Brescia's groundbreaking *La Mimetizzazione delle Navi Italiane 1940–1945* published in 2006 (reviewed in *Warship 2007*, 191–92), Marco Ghiglino draws on additional material discovered in the intervening years to provide an up-to-date account of the subject to an English readership.

The book is divided into two parts. The first third –

some 59 pages spread over 11 chapters – describes the development of the Italian Navy's use of camouflage from the First World War onwards. It also looks at applications to specific types of vessel such as submarines and merchant ships, as well as in specific theatres and circumstances. It is clear that the *Regia Marina* was somewhat 'behind the curve' with camouflage development when Italy entered the war and it was not until the end of 1941 that a standardised approach was adopted. It is also interesting that – in contrast, for example, with the British Royal Navy's approach – the Italian focus was entirely on disruption (ie deception with respect to identity, course and speed) rather than concealment. The author's text is well supported with photographs and official drawings, increasing the authority of his analysis.

The remainder comprises the author's extensive series of colour profiles depicting the various schemes adopted on a ship-by-ship basis. These are sub-divided into ten sections grouped by warship type and an eleventh illustrating armament and radar equipment. The profiles are clearly drawn and supported by explanatory text and photographic evidence. The depiction of the patterns applied to major units such as battleships and cruisers is inevitably more comprehensive than that used by minor warships and auxiliaries, but even these receive good coverage. There are, however, no plan views. Another omission is the lack of a section on submarines. This is largely because the author concluded it was virtually impossible to distinguish different boats by their camouflage schemes due to the small size of each patterned area.

All in all, Ghiglino has produced an excellent book on a little-studied subject. His initial overview provides a concise yet thorough evaluation, helping put the following profiles in context. The supporting photographic and other documentary evidence – much of it in colour – means that the reader has to take less on trust compared with some other recent camouflage studies (although even this evidence is still far from comprehensive). The fact that he does not attempt to conceal the gaps in the available evidence further enhances the book's credibility.

Combined with strong production values and a clear, well-laid out design, *Italian Naval Camouflage of World War II* sets a high standard against which other books focused on naval camouflage are likely to be measured.

Conrad Waters

Dougie Martindale

Gunther Prien and *U-47*: The Bull of Scapa Flow

Frontline Books, 2019; hardback, 450 pages, 70 photographs, maps and drawings; price £25.00.
ISBN 978-1-52673-775-5

The sinking of the *Royal Oak* in the supposedly 'safe' anchorage of Scapa Flow was an enormous propaganda success for Nazi Germany and delivered a huge blow to the Royal Navy; it also changed the landscape of the Orkney Islands forever. While many books have simply retold the events of 14 October 1939, here Dougie Martindale goes right back to the beginning to tell the full story of this most famous U-boat in microscopic detail. A short preface explains how he researched and wrote the book over a period of seventeen years – a depth of study that shows on the page.

The book has five sections: a brief history of the Battle of the Atlantic, a detailed service history of *U-47*, an account of the attack on Scapa Flow, an analysis of the surrounding controversies, and finally a crew history of the U-boat. The book is packed with detail, yet it never becomes a dry read, making it both suitable for new readers to the subject and satisfying for the more experienced historian. Particularly interesting is the detailed refit information in Chapter 2, which shows how the U-boat was repaired, upgraded and improved as new technologies were introduced throughout the early months of the war. The account of the attack covers not only the planning and execution, but also the history of the naval base and its defences, and attempts to explain why things happened the way they did; the chapter ends with a useful list of related events in Orkney waters, from the loss of HMS *Hampshire* in June 1915 to the discovery of an unexploded torpedo in Scapa Flow as recently as 2016. In dealing with the many complex controversies and conspiracy theories surrounding the attack the author addresses a number of technical questions, and this has involved a great deal of research and methodical detective work. The chapter covering the crew of *U-47* has detailed biographies of several of those on board; unsurprisingly, Prien receives the most attention, but other officers included Englebert Endrass, who later went on to become a U-boat captain in his own right.

Overall Dougie Martindale has produced a book broad in scope yet so detailed that it can be read and enjoyed *and* kept for reference. Despite writing about a subject that has already been covered extensively, he has found much new to say and the end result is something of a definitive work, comprehensively researched, well written and full of information and analysis.

John Peterson

Gareth Glover

The Two Battles of Copenhagen 1801 and 1807: Britain & Denmark in the Napoleonic Wars

Pen and Sword, Barnsley 2018; hardback, 277 pages, illustrated with 7 maps and 24 colour plates; price £25.00.
ISBN 978-1-4738-9813-8

This book is effectively about diplomacy and political manoeuvrings, given Denmark's neutral status during the Napoleonic Wars. The failure of Nelson and Hyde Parker to destroy the Danish fleet in 1801 raised the spectre in British minds of it falling into Napoleon's hands, prompting the 1807 bombardment, this time accompanied by 'boots on the ground', including those of the future Duke of Wellington. The two actions were linked in much the same way as the two Gulf Wars – a parallel that has not escaped the author.

The first nine chapters deal with the lead-up to the 1801 bombardment: the trading rivalry of Britain and Denmark, the League of Armed Neutrality, and Denmark being drawn into a conflict it had hoped to avoid, having became a pawn in wider political intrigues. Subsequent events, very much a part of the Nelson mythology, are well known. Glover details the opposing forces and examines the motivations behind both Hyde Parker's and Nelson's actions, as well as the diplomatic wrangling that followed. There followed five years of relative harmony before Napoleon's 1806 Berlin Decrees forbidding all trade between Europe and Britain. Britain's response left Denmark once again between a rock and a hard place. Copenhagen, subjected to naval bombardment and siege, submitted and the Danish fleet and its naval stores were either destroyed or taken back to Britain.

Overall, Glover has produced a detailed, well-researched and well-presented book that sensibly ties the two actions together, the strategic failure of 1801 making 1807 inevitable. There are some minor mistakes and typographical errors, and the level of detail in sometimes overwhelming: there are no fewer than 36 appendices. Nevertheless, this is a thoroughly engrossing book, good value for money, and definitely recommended.

Andy Field

Kathleen Broome Williams

Painting War: George Plante's Combat Art in World War II

Naval Institute Press, 2019; hardback, 280 pages,
with 25 illustrations in B&W and colour; price $29.95.
ISBN 978-1-68247-426-6

George Plante was a Scottish artist whose skills, spotted early in the Second World War, were turned to good use as a propagandist supporting the prolific Allied leaflet programme. In later life he became a significant figure in the UK and then US advertising industry. The author of this fascinating biography is his step-daughter.

Details of Plante's wartime work have been skilfully culled from his letters, surviving publications and his few preserved works. Despite the blanket of secrecy which shrouded much of the political or, as it became known, psychological warfare waged in Europe, the author has put together a very coherent narrative from her research.

The first half of the book sets the scene before covering Plante's life at sea as a 'volunteer merchant navy radio officer', his survival of a torpedoing, and recognition as a war artist. The remainder covers his work providing illustrations for leaflets, newspapers and magazines for the psychological war effort. Compared with the difficulties of painting at sea under fire this might seem a comfortable billet, but the figures for leaflet publication suggest that the work must have been highly pressurised. In September 1943 alone, 115 different leaflets were printed with a total print run of 59,482,200!

The illustrations cover Plante's time afloat and a few of his many leaflets, plus a couple of post-war examples, one of which suggests he was a very good artist in his own own right. By the author's own admission there is little on the paintings Plante produced and, indeed, exhibited during the war and after, while the brief coverage of his postwar work suggests scope for a further volume, albeit one hard to categorise under the banner of maritime history.

W B Davies

Zvonimir Freivogel

Pearl Harbor: December 7th, 1941

Despot Infinitus, Zagreb 2018; large format softback, 258 pages,
over 300 photographs, maps and drawings; price €39.90
ISBN 978-953-7892-99-9

The attack on Pearl Harbor was one of the turning points of the Second World War and arguably of the 20th century. Looking back after almost 80 years, the events leading up to the attack can be seen to have followed each other like the acts of a Greek tragedy. For Japan it was a supreme strategic misjudgement, bringing a united America into the war; for the IJN it was a major tactical blunder: the slow battlewagons were smashed, but the fast carriers, the capital ships of the future, were safely away at sea, while the naval base itself was not targeted.

The author describes this book as a labour of love; he returned to it after a gap of many years writing on other naval topics. Following in the steps of many previous accounts, it deals comprehensively with the build-up of the rival navies, particularly their air arms, and with all aspects of the attack. In addition to the stricken battle line, the lesser ships and aircraft are fully treated. Preceeding events in Southeast Asia are narrated and analysed impartially. The book is spacious, well-researched and thorough, and generously produced on good-quality paper. Full advantage has been taken of the very numerous photos available; the line drawings are from several sources.

There are occasional typos and obvious mistranslations, and a photo of *Arizona* is captioned incorrectly. Otherwise this is a good, workmanlike book on a topic of absorbing interest.

Ian Sturton

Vice Admiral B B Schofield
(ed Victoria Schofield)

With the Royal Navy in War and Peace: O'er the Dark Blue Sea

Pen & Sword Maritime, Barnsley 2018; hardback, 288 pages,
5 plans and 32 photographs; price £25.00.
ISBN 978-1-52673-647-5

With the Royal Navy in War and Peace constitutes the personal memoirs of Brian Betham Schofield CB CBE (1895–1984) from the time of his entry into the Royal Navy as a naval cadet in 1908 to his retirement as a vice admiral in 1950. His recollections, written in 1956, quite soon after leaving the RN, have not previously been published. They have been edited by his daughter Victoria Schofield, herself an author and commentator. The inclusion of a very comprehensive and helpful set of notes is one benefit of her involvement.

After her brief foreword the bulk of the book comprises eighteen chapters arranged in chronological order. The story commences with the twelve-year-old Schofield at the Admiralty interview board, presided over by the then-First Sea Lord Admiral John Fisher. We pass quickly to the First World War, where service in the battlecruiser *Indomitable* in the Mediterranean is quickly followed by the ship's transfer to the Grand Fleet. A highlight of this time is Schofield's description of the excitement of the stern chase at Dogger Bank.

The inter-war years form a major part of the book and provide an interesting picture of service in the colonial era. This includes the glamour of a Royal tour of North America with the Prince of Wales while embarked in *Renown*, and the highs and lows of policing the Indian Ocean and Persian Gulf as navigating officer aboard the cruiser *Enterprise*. A navigation specialist, Schofield also undertook navigator roles aboard the battleship *Malaya* and the cruiser *Orion* and as a staff officer (operations) aboard *Nelson*. Promoted to captain in 1938, his linguistic abilities saw him serving as Naval Attaché to the Netherlands at the outbreak of war, but by early 1940 he was in command of the cruiser *Galatea*. A subsequent desk job as Director of the Trade Division – tasked with protecting merchant shipping – was initially a disappointment. However, it provided a ringside seat at many of the war's major political conferences and an opportunity to observe some of its most famous personalities.

Schofield returned to sea as captain of the battleship *Duke of York* in 1943 but his wife's ultimately terminal illness forced him to relinquish command just a few days before the Battle of the North Cape. After a period organising the naval headquarters for D-Day, he was back in the frontline commanding *King George V* during the final stages of the war against Japan.

In spite of having only limited exposure to the major naval engagements of the two World Wars, Schofield had a diverse, successful career spanning a period that began with the introduction of the dreadnought battleships and ended in the early atomic age. In retirement, he became a respected naval author and historian. Schofield's memoirs provide a historian's account of his distinguished service but, frustratingly for the reader, hold back on providing a more personal perspective.

Conrad Waters

Adrian Stewart
The War with Hitler's Navy

Pen & Sword Maritime, Barnsley 2018; hardback, 212 pages,
41 B&W illustrations; price £19.99.
ISBN 978-1-52671-057-4

This book examines in detail the many theatres in which the Allies and the *Reichsmarine* fought, and endeavours to analyse the ultimate outcome. Chapter 1 sketches the interwar years, covering the Versailles Treaty; the Weimar Republic, Hitler and rearmament, the Anglo-German Naval Agreement of 1935 and the reoccupation of the Rhineland. The main chapters describe the surface battles of the River Plate, Narvik and the North Cape, and the sinking of the *Bismarck*. Attacks on the Atlantic and Arctic convoys culminated in the defeat of Grand Admiral Dönitz; the last chapter encompasses the final destruction of the *Reichsmarine*. The coverage is comprehensive, detailed and factual; all major and many minor events are treated in full, and telling quotations illuminate numerous episodes. Considerable space is given to the less familiar Baltic campaigns, and those in the Mediterranean, the Adriatic and the Aegean.

The bibliography suggests a reliance on elderly secondary sources, with very few entries post-dating 2000, meaning information on, for example, casualties from *Blücher*, is suspect, and there are a number of straightforward mistakes (a photograph of an American destroyer escort is captioned as a pocket battleship!). Nevertheless, this is a worthy addition to the maritime bookshelf.

Ian Sturton

Quentin Falk
Mr Midshipman VC: The Short Accident-Prone Life of George Drewry, Gallipoli Hero

Pen & Sword Books, Barnsley 2018; hardback, 176 pages,
illustrated with B&W photographs; price £19.99.
ISBN 978-1-52672-624-7

On 25 April 1915 British troops landed at Cape Helles on the south west tip of the Gallipoli peninsula, many from SS *River Clyde*, a collier modified to allow them to disembark through sally ports cut in the hull. Despite a heavy bombardment the defences had not been neutralised and as the attackers approached the shore, withering fire inflicted heavy casualties. In the confusion, *River Clyde* grounded out of position and it was left to a couple of young officers to manhandle several lighters and tie up the collier to allow the troops to disembark.

Midshipman George Drewry, just 20, was one of those brave young men who under vicious fire displayed such courage and determination and, despite being injured in the head, becoming the first RNR officer to earn the nation's premier award for valour, and it is this action that forms the main part of the book. However, we also get a glimpse of his childhood, along with his experiences later in the war until his accidental death at Scapa Flow, prematurely ending a short but action-packed life.

Using contemporary sources, Quentin Falk, a former film critic and show-business journalist, has brought Drewry back to life in an engaging biography that also captures the spirit of the period. Details of the heroic act, limited to just four letters home to his father, written after the award of the VC, are combined with newspaper, magazine and even comic book accounts of the young officer's exploits to tell a compelling story in lively style.

Frustratingly there are no footnotes, nor are Drewry's letters reproduced. Indeed, the author describes the final chapter as 'a careful blend of fact and some speculation, finely spiced with just a jot of confusion'. That aside, this is a thoroughly good read from an experienced author, telling the story of a forgotten hero.

Phil Russell

WARSHIP GALLERY

Cold War Fleet: Ships of the Royal Navy, 1966–1991

Assistant Editor **Stephen Dent** introduces a selection of photographs that accompany the new book *Cold War Fleet* by **Clive and Sue Taylor**.

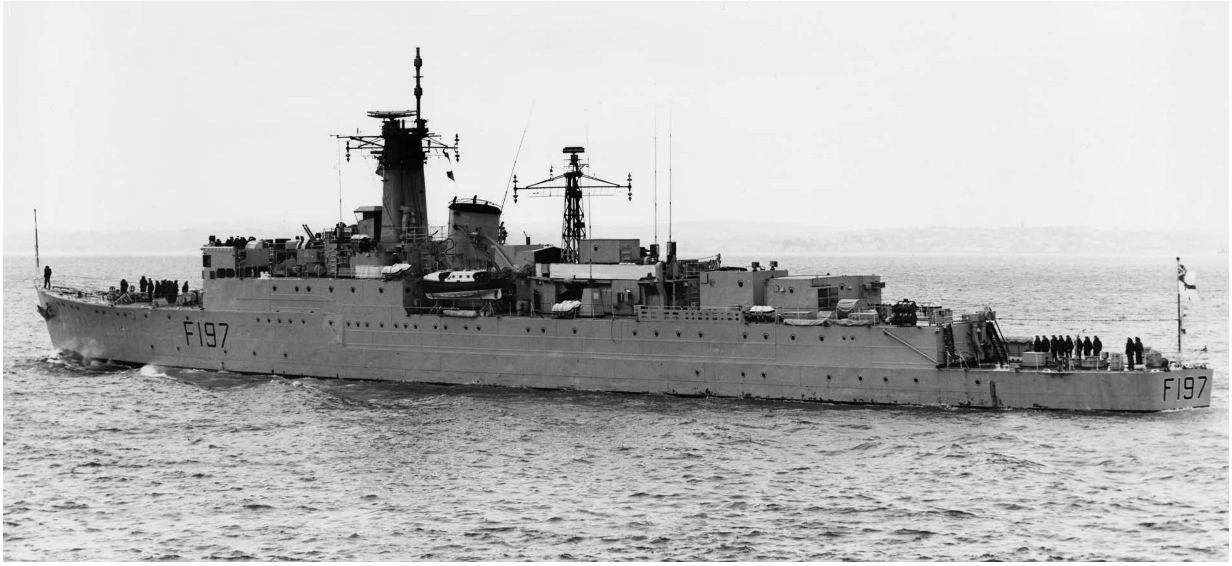
In the spring of 2019 *Warship*'s publisher, Osprey, published *Cold War Fleet*, a large-format photographic survey of the ships of the Royal Navy during the quarter century 1966–1991 – the second half of the Cold War era. This was a time which not only saw the Navy engaged in ongoing activities aimed at countering the perceived threat of the Soviet fleet, but also several more high-profile operations, of which the 1982 conflict in the South Atlantic is by far the best-known. In addition, in 1977 there took place the Silver Jubilee Review at Spithead, when the greater portion of the fleet was gathered together, decked out in its ceremonial best.

This period was arguably the last time that the RN, although part of the larger NATO alliance, was able to operate a truly balanced fleet which, while tiny compared to its heyday earlier in the 20th century, was still large enough to be able to field both the number and the range of vessels necessary that, when the time unexpectedly came, it was able to fight a full-scale 'hot' war while still carrying out other commitments elsewhere.

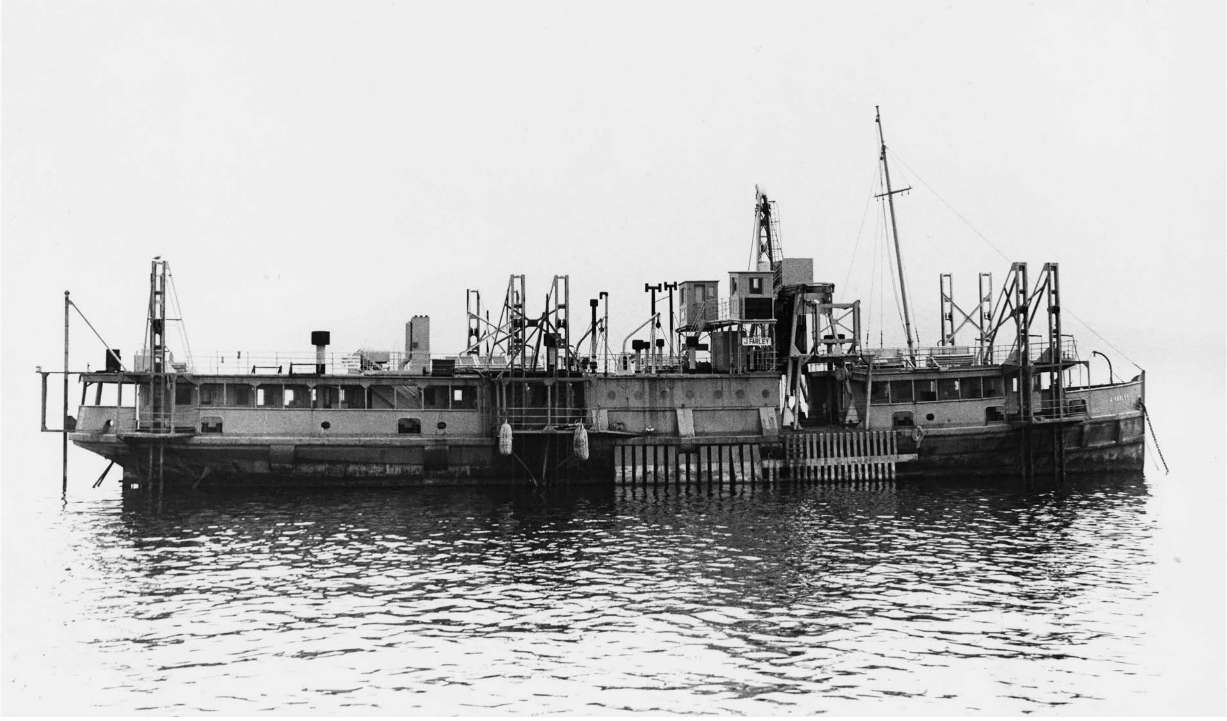
Throughout the period the RN's ships were thoroughly documented by photographers Clive and Sue Taylor. Beginning in the late 1960s by taking photographs just as a hobby, by 1970 they were operating under what became the well-known byline 'C & S Taylor', supplying images for numerous publications (including *Warship*) as well as various official agencies both in Britain and overseas. This was achieved with the support of the MoD, with the result that in time the photographers' vantage points expanded somewhat, from the top of Portsmouth's famous Round Tower and its adjacent ramparts to include views taken from MoD helicopters and privately chartered light aircraft. The Taylors worked in medium format, using slightly longer than standard focal length to produce photographs of a clarity, perspective and definition similar to those of classic photographers of earlier years such as Wright & Logan.

Here *Warship* presents a series of pictures which for one reason or another did not quite make the final editorial 'cut' (detail views, for example, were largely omitted), but which still serve to give a flavour both of the book and also of a time when the waters around Portsmouth Harbour were still a bustle of warships and their supporting craft, all going about their business, from setting off on world-wide deployments to carrying stores from one side of the harbour to the other.

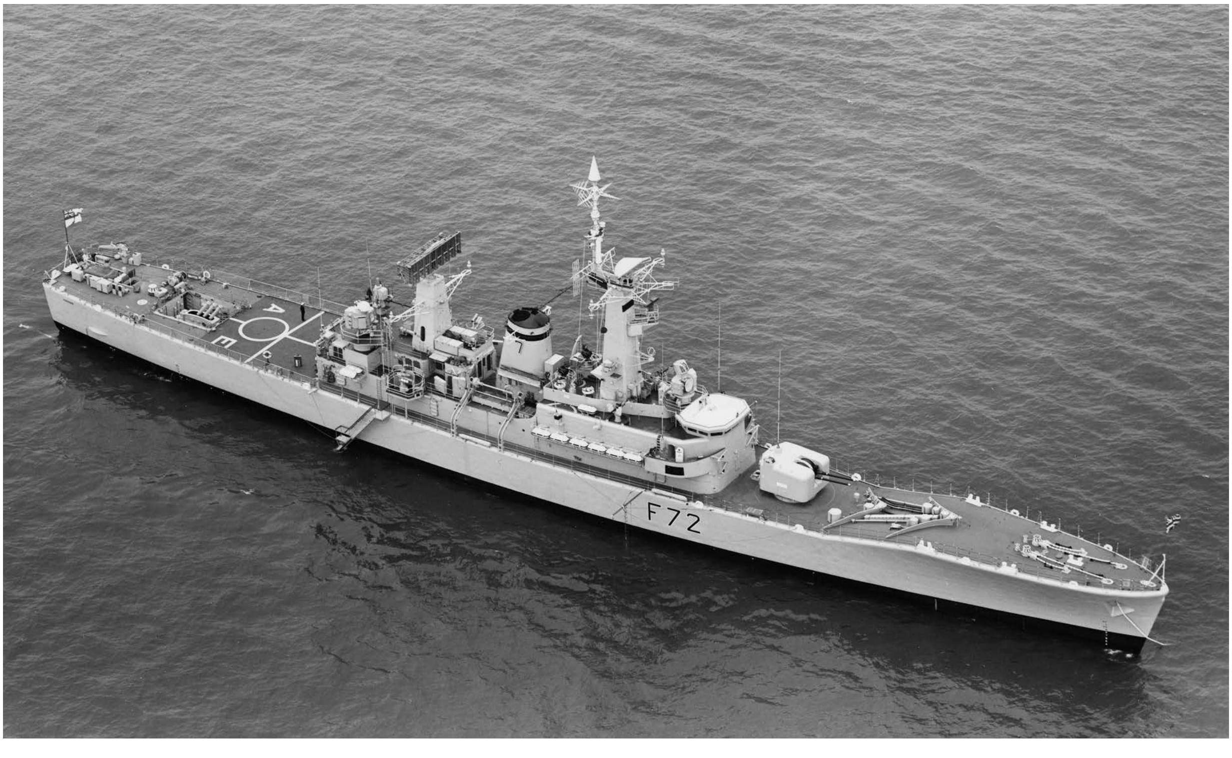
(All photographs © Clive and Sue Taylor, 2019)



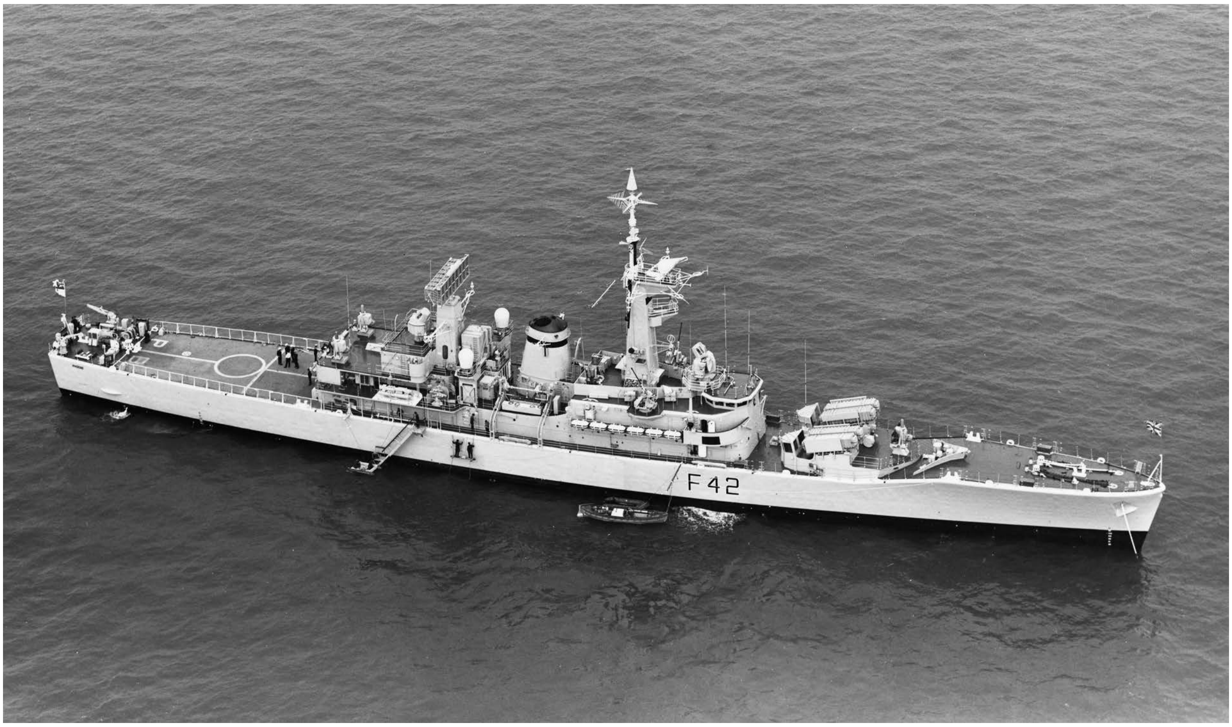
Grenville **1974**
Formerly a destroyer with a notable combat record during the Second World War, *Grenville* was rebuilt as a Type 15 anti-submarine frigate during 1951–54. By the time this photograph was taken she was coming towards the end of a third career, as a trials ship for the Admiralty Surface Weapons Establishment at Portsdown, evidenced here by the various temporary structures added aft.



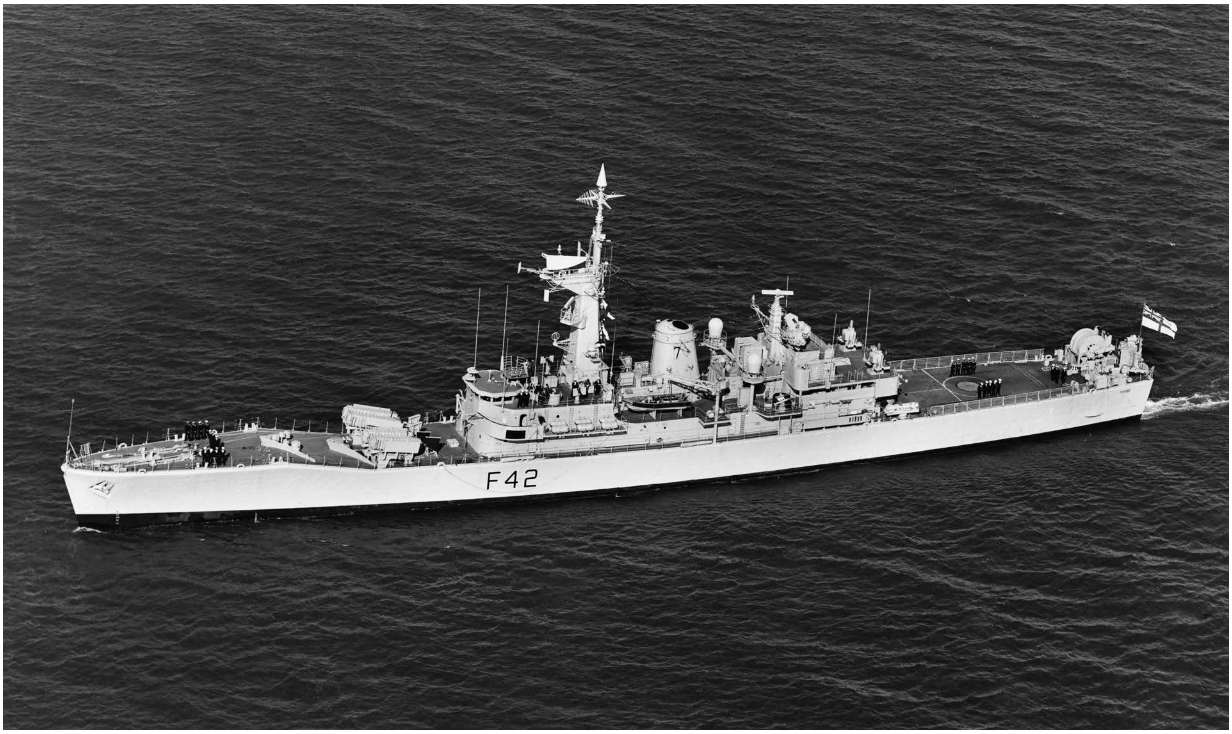
J Farley
Little-known, *J Farley* was a former Mersey ferry of 1922 acquired in 1952 for use as a floating laboratory for the Admiralty's underwater weapons development establishment in Portland harbour. With her engines removed, she served until 1974 when she was replaced by the much larger, purpose-built RDV *Crystal* (see the article by Peter Marland in this year's annual), whose unique and utterly unconventional appearance dominated the harbour until the closure of the naval base in 1992.



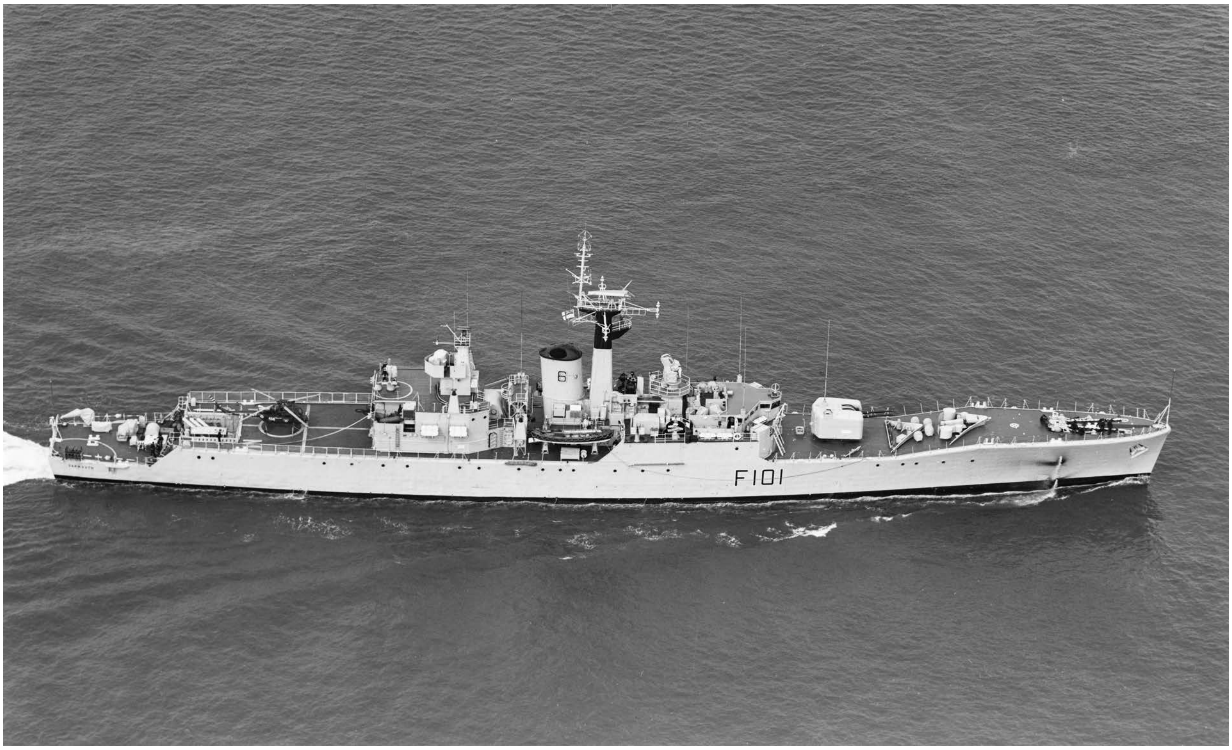
***Ariadne* June 1977**
Ariadne was the final frigate of the *Leander* class to complete, and is shown in her original form, with twin 4.5in guns, Seacat and Limbo, as well as the full UA-13 'Dunce's Cap' ESM array atop her foremast.



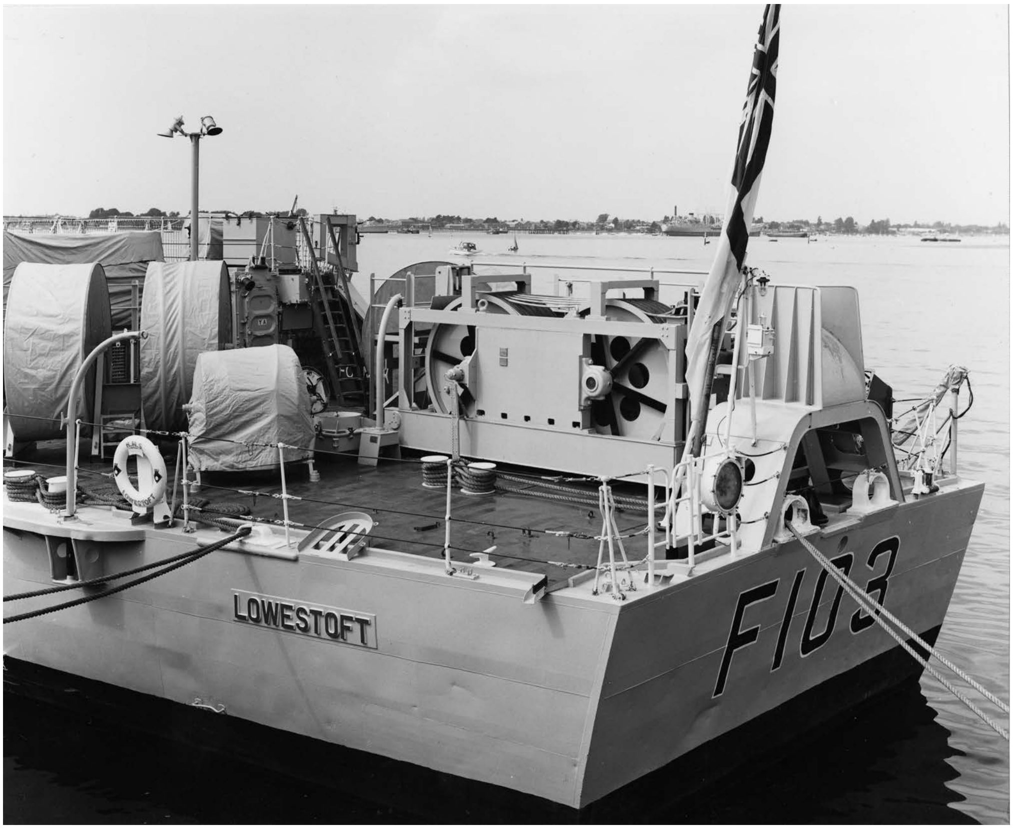
Phoebe June 1977
Many of the photographs in the book were taken at the time of the 1977 Silver Jubilee Review. Here *Phoebe* is having some last minute touching-up to her paintwork. She was one of the first *Leander*s to undergo conversion to carry the Exocet missile system, which is prominent in this photograph, together with her three Seacat launchers, Bofors guns and SCOT on the superstructure amidships, and the extension aft of the helicopter deck to accommodate the Lynx.



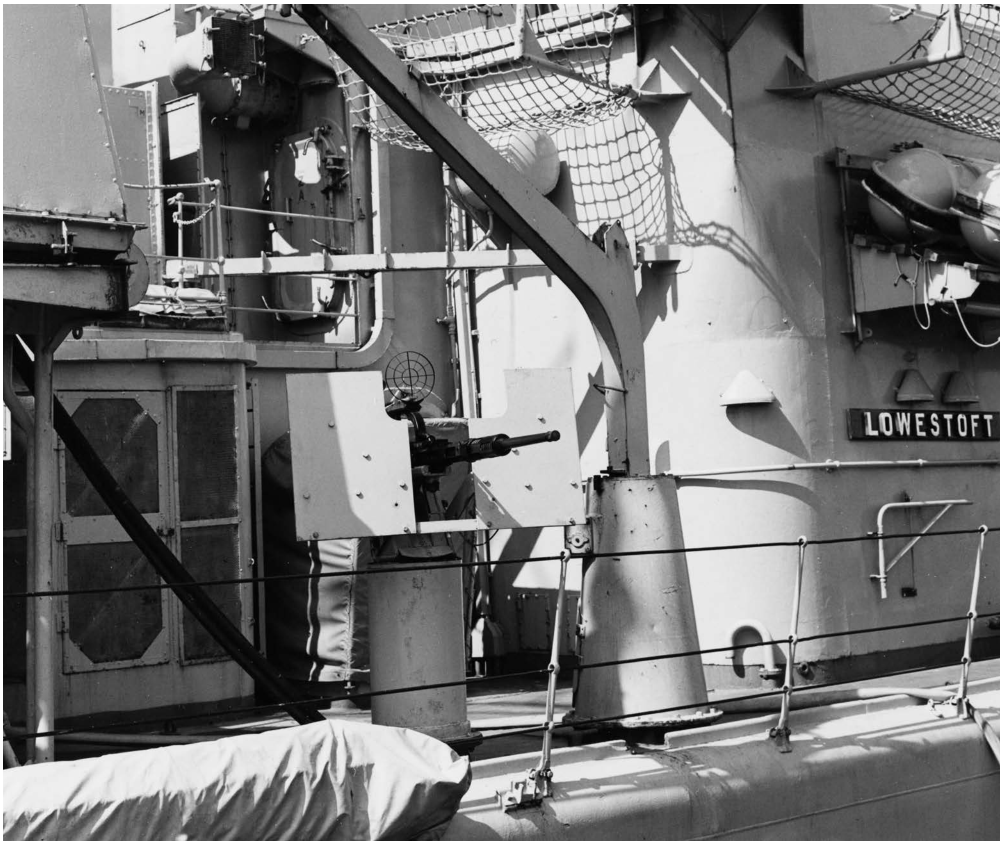
Phoebe May 1985
Phoebe is shown after being refitted with Towed Array Type 2031 and two triple 12.75in torpedo mounts. She retains her Type 993 radar aerial and 'Dunce's Cap', but has lost her forward Seacat launcher in order to save weight.



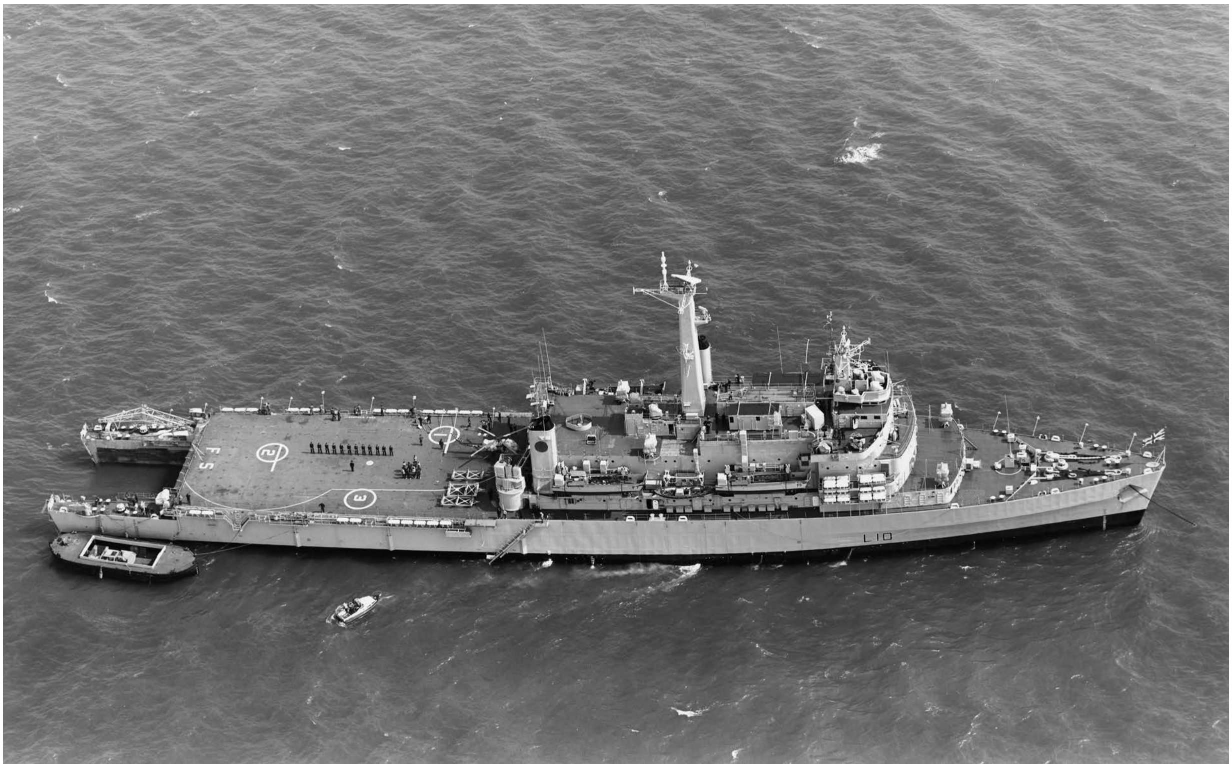
***Yarmouth* June 1977**
This view gives a good idea of the *Rothesay* class as refitted with a small flight deck and hangar for a Wasp helicopter replacing one of the Limbo A/S mortars. The addition of a Seacat launcher resulted in a ship not so far off a *Leander* in terms of capability. *Yarmouth* was one of two ships of the class to see service in the Falklands conflict.



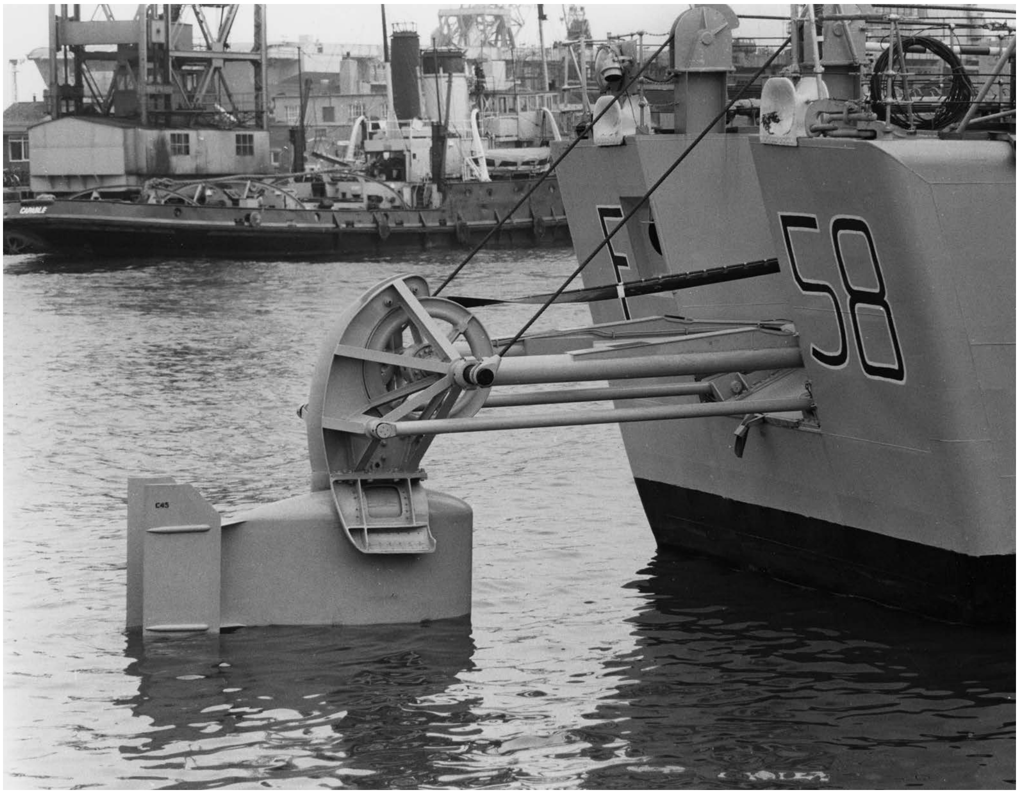
Lowestoft
August 1979
Prototype of Towed Array Type C30F. The weight of the cable was considerable, and it was rumoured that the original intention had been to fit it to most of the *Rothesay* class but that this was cancelled due to concerns about stability. In the background is RNAD Priddy's Hard, moored off which are various older ships including a *Daring* class destroyer, the Type 14 frigate *Grafton*, and an RFA.



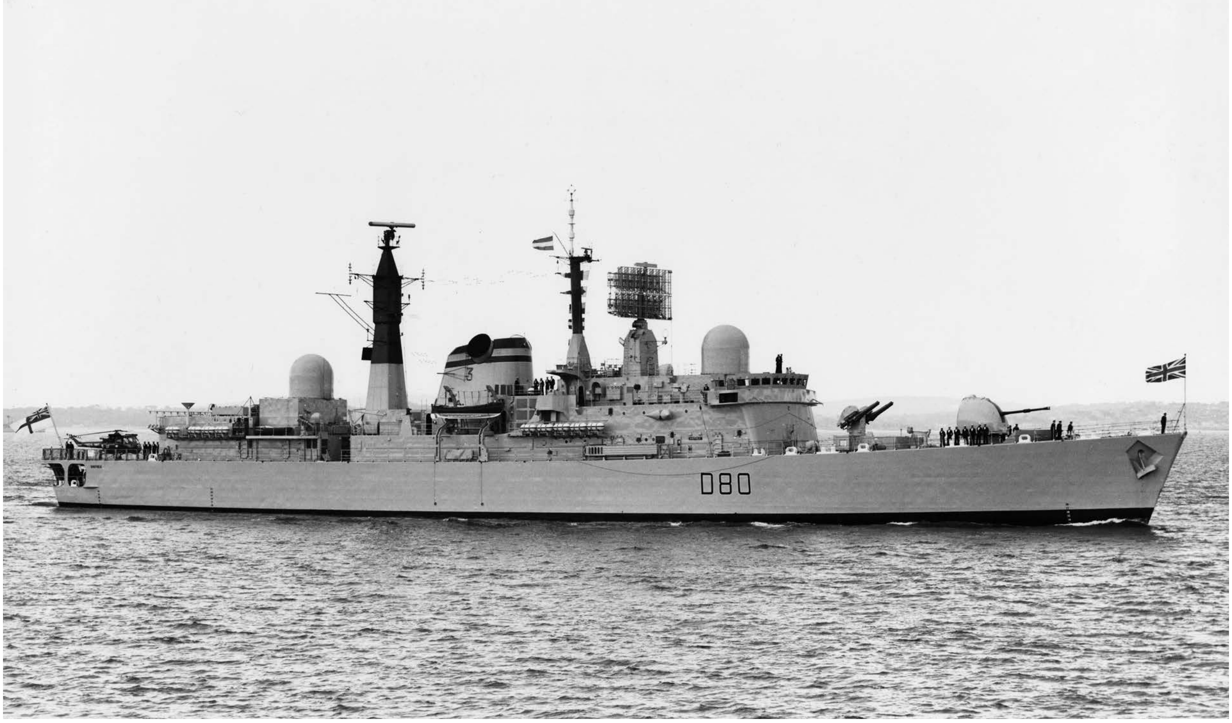
Lowestoft
August 1983
20mm Oerlikon fitted amidships for the Falklands conflict.



Fearless May 1977
Fearless is shown fully flooded-down, and with a 'gash barge' on her starboard quarter. Floodlighting booms have been rigged to port, during rehearsals for the Silver Jubilee Review.



***Hermione* around August 1972**
Variable Depth Sonar Type 199 is deployed. Type 199 was a small towed sonar intended for installation aboard frigates; it was fitted in some *Leanders* and 'Tribals'.



Sheffield 1977
Sheffield, the first Type 42 destroyer, is here shown wearing the funnel band of a half-leader. The distinctive 'ears' on the funnel were a modification fitted only to her and to her two Argentine sisters; intended to deflect hot exhaust gases away from electronics on the mainmast, they proved unnecessary and were omitted from the rest of the class. The earlier Batch 1 and 2 were much criticised due to their cramped layout (the later Batch 3 was longer); the Type 42s nevertheless went on to provide the Royal Navy with sterling service for over thirty years.